INTERNATIONAL

ElectronicDesign

FOR ENGINEERS AND ENGINEERING MANAGERS—WORLDWIDE

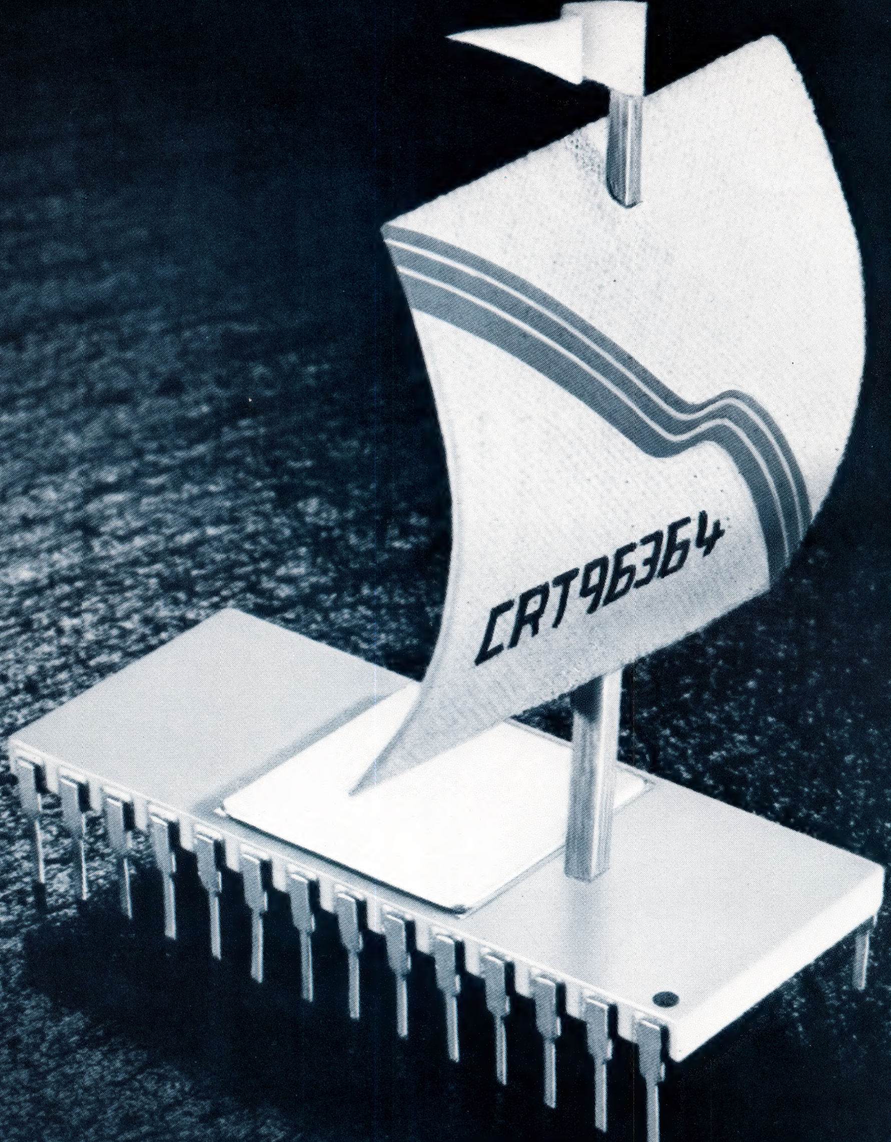
MAY 24, 1980

Special Report: Pots and trimmers tighten tempcos, live longer

Short-haul fiber-optic links tumble in price, slip onto PC boards

Magnetic printers promise quiet yet super fast operation

Single-chip microcomputer commands the most memory



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*Domestic US price only. Offer expires August 31, 1980.

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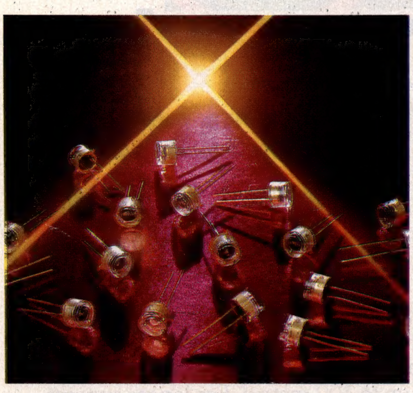

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Design

57 Microcontroller works in Boolean (cover).

Besides packing enough density to quadruple the memory capacity of the 8048, the 8051 single-chip microcontroller works on bits and bytes.

65 Three technologies forge a better fiber-optic link.

The three parts of a multichannel, fiber-optic system come from three manufacturers, but operate at their best when used together. Crimp-on diode connectors join the new semiconductors to plastic-fiber cables.

75 Timer/counter schedules μC interrupts—simply.

The MC6801 system on a chip has eight operating modes and a powerful instruction set. It also features a complexity-reducing timer/counter.

85 Single-supply 16-k, 64-k RAMs ease upgrading.

To upgrade from 16-kbit dynamic RAMs to 64-k without complicating the memory system, simply use interchangeable, 5-V-only devices.

93 Large-scale s parameters help analyze stability.

Derived from techniques similar to those that approximate small-scale s-parameters, the large-scale s parameter identifies the source of instability in simple, single-stage amplifiers.

103 Video terminal strips down to 26 MOS/LSI chips.

Single or multiple-chip sets implement the complex functions of a video terminal—programmable I/O and counters, keyboard scanner and encoder, baud-rate generator, memory and video timer and controller.

117 Ideas for Design:

Over/undervoltage indicator powered by circuit monitored.
Improve programmed-I/O rates without complex DMA.
Optically isolated driver controls inverse-parallel SCRs.

Products

125 Focus on pots and trimmers

Pots and trimmers are bringing improved resistance, tolerance and tempco values in smaller packages to analog signal processing.

133 **Microsystems:** 16-kbyte RAM board retains data for 7 days.
136 **Analog Circuits:** DAC with BCD inputs works like attenuator.
138 Servo IC for radio control helps conserve power.
140 **Packaging & Production:** Straight pull improves fiber breaks.
144 Automatic tester saves space.
148 **Components:** Precision resistors pack smaller size and cost.
156 **Digital Circuits:** Nonvolatile counter needs only one supply.
161 **Peripherals:** Tape drive quadruples density to 6400 bpi.
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Coming in the June 7 issue:

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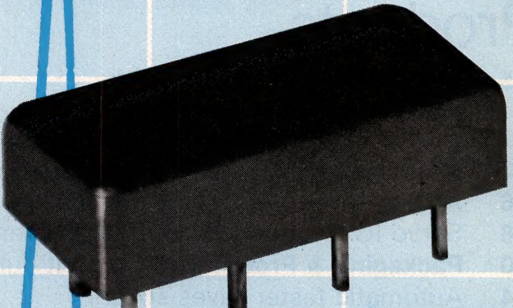

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Editorial Offices:
50 Essex St., Rochelle Park, NJ 07662
(201) 843-0550, TWX: 710-990-5071
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West Coast: 1307 S. Mary Ave., Suite 212
Sunnyvale, CA 94087. (408) 736-6667

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Publisher's Memo

Fiber optics, one of the most exciting and fast-paced technologies in electronics today, brings together a trio of engineers from different companies and different areas of expertise. The result is a joint venture that goes a long way towards establishing a standard for fiber-optic links while tying together the best of cable technology, the best of emitter and detector semiconductor technology, and the best of connector technology. ELECTRONIC DESIGN is proud to present the first details on how to design with this landmark link.

The experts are Ron McCartney, product manager for fiber-optic microminiature products at ITT Cannon; Jay Uradnisheck, marketing specialist at DuPont; and Gary Null, assistant vice president at the Spectronics Div. of Honeywell.

With a background that includes development engineering at both Lockheed and Raychem, McCartney was undoubtedly the prime mover and catalyst here. Some years ago he realized that the fiber-optic area was sorely in need of standards. One way to promote a standard, he believed, was to have manufacturers of different types of products agree to a common configuration.

Since joining Spectronics in 1974, McCartney has been seeking the common ground that would lead to a new standard. His quest took him across the country several dozen times. Once he found the right people, however, things fell into place.

For expertise in fiber-optic cables, McCartney turned to DuPont's Uradnisheck, a postgraduate chemist from the University of Southern California. A dinner at last September's fiber-optics conference in Chicago got the two men—and their companies—talking.

For semiconductors, McCartney found his man in Null, with more than 15 years of design experience in optoelectronics, including a five-year stint at Texas Instruments. A meeting took place that same September, but at Wescon in San Francisco.

All three came together for the first time in November, at the military hardware show in Washington, DC. Formal agreements soon followed—after another meeting at Spectronics in early December, and two meetings at Cannon. The three companies were enthusiastic over the prospect of getting together on a fiber-optic system, as long as there was no restraint of fair trade.

For details about the new system, turn to p. 65 for "Three Technologies Forge A Better Fiber-Optic Link."

Larry Altman

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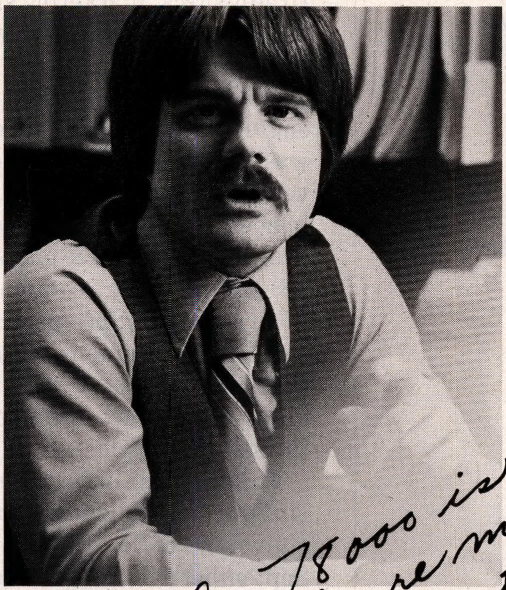

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Product Marketing Manager,
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"The AmZ8000 is better for small business computers."

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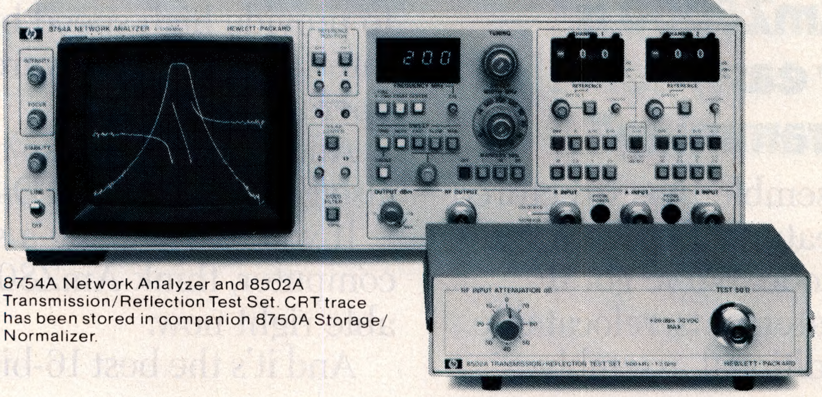

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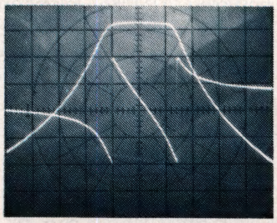

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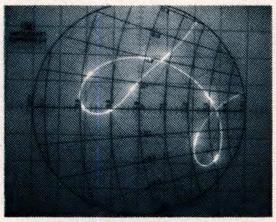

Measure and display impedance in polar form, with crystal markers to give precise frequency data. Test sets are available for both 50 and 75 Ω systems.

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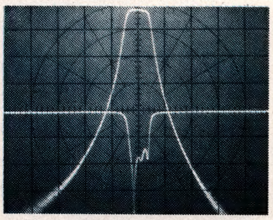

Use the 8502 Test Set ($2000) and see the trade offs between transmission gain/loss and input match in a single setup. For two-port characteristics of networks, including transistors, an S-parameter test set is available.

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CIRCLE NO. 7

Editorial

What the inventor loses when the employer gains—everything

An engineer working for a large industrial company makes an important invention that is unquestionably tied to his work. In fact, the company hired him specifically to make that invention or its equivalent. To whom, then, does the invention belong?

Patents are always issued to people, not to companies. So most companies make it a condition of employment that engineers sign away their right to any patents they may acquire while working for the company. The usual justification is that, without the company's equipment and research libraries and the intellectual stimulation of its other employees, the engineer would not have conceived the invention.

One may equally well argue, however, that all of the equipment, books and stimulation in the world will not generate an invention without the right person drawing the right conclusions at the right time. Inventing is a creative act, and the creator certainly has an interest in his creation. A few companies recognize this by providing compensation clauses in their patent agreements.

It seems to us that both the inventor and the company have legitimate claims on the profits resulting from inventions made on company time. The trouble is that engineers who feel this way are, at present, not in a position to do anything about it. If they refuse to sign the company's standard patent agreement, they are not hired.

A guild or union or professional society—such as the IEEE—could wield some influence on behalf of the working engineer, but this is not happening. While engineers, for a variety of reasons, have resisted unionization, the IEEE has spent the last two years developing a model patent agreement that it now seems ready to scrap. According to an article in the May 1980 issue of *The Institute* some members of the IEEE's U.S. Activities Board favor protecting the rights of working engineers through laws rather than through a model agreement.

We agree. Even the best of model agreements is no more than a model. A law limiting the employer's interest to, say, 50% makes sense.

Strange bedfellows—the electronic way

The proposed election of the president of the United Automobile Workers to the board of directors of Chrysler Corporation not only raises questions of potential conflict of interest, but also tickles our imagination. Suppose our industry followed the lead of the automotive industry and put our own dissonant characters on the same committees. Imagine, for instance, the following conversation taking place at the weekly Monday morning meeting of the Advanced Planning Group of TMC (Try My Chip) Inc. (Santa Clara, CA):

"O.K., O.K., settle down everybody," exhorts committee chairman I.M.A. Kluge. "We're here to determine what to do next, not to pin blame because our last brainstorm didn't pan out. After all, climate-control ICs sounded like a good idea at the time."

"I keep telling you," returns W.S.T. Broker, "they don't understand all that technical stuff back at the Exchange. I need to recommend something that'll churn up some hot portfolio action. How about us developing an IC that balances downside risk against upside reward? I'd call that bullish."

"You're out of line," warns General Mils, TMC's quality-control overlord. "Either you develop a chip that works from −1000 to +1000 C or I pick up that red phone over there. The boys back at Strike Force 8080 are still pretty sore over the failure of those air-conditioning ICs during their last action in the valley."

"Squabble, squabble, squabble—no wonder we're losing money left and right," Comp E. Tition uneasily complains.

"Shut up, Comp," shouts Kluge. "I'm sick of your constant disruptions. Just wait until Wednesday, when I make my report to the financial-planning committee over at your place. I'll fix your wagon then."

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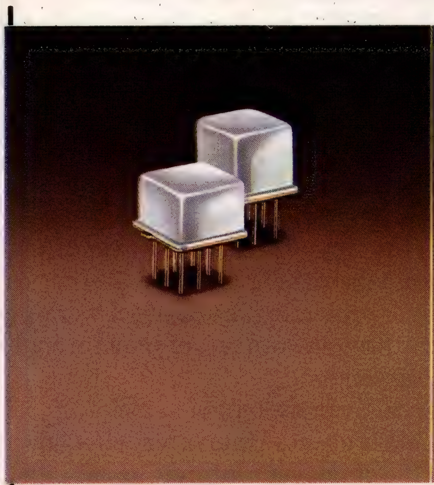

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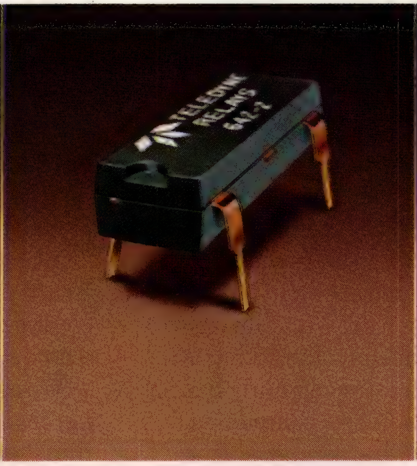

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☐ Are speed, long life, and bounce-free operation the only SerenDIP advantages?

☐ How does the TO-5 relay get its excellent RF characteristics?
☐ What gives these TO-5 relays reliable contact rating from dry circuit to 1 amp?
☐ Why use a hermetically sealed relay in a commercial environment?

Sorry. You missed my question. Here it is. ______________________

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CIRCLE NO. 6

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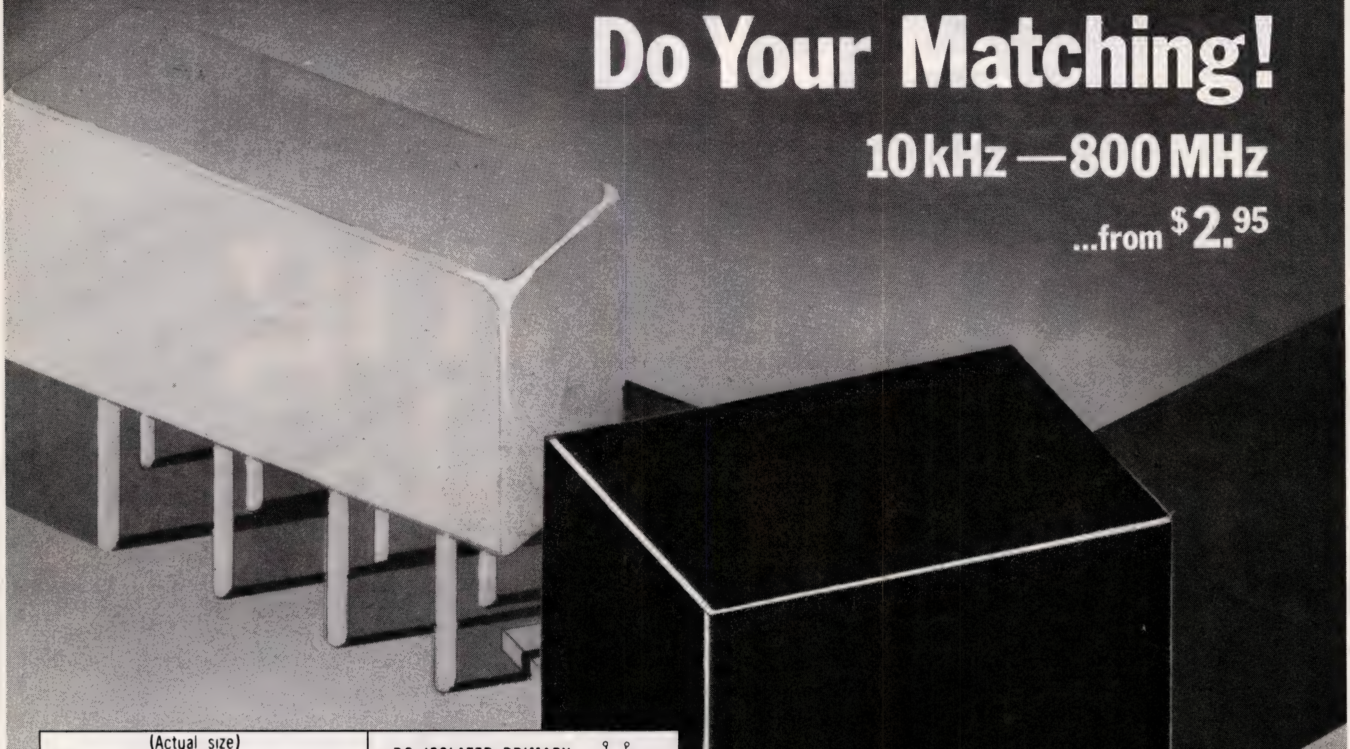

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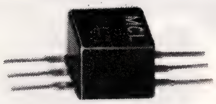
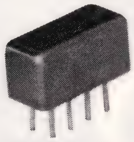


Models T, TH (Plastic case)
(0.300" sq. × 0.230" high)

(Actual size)



Model TMO (Metal case)
(.500" L × .230" W × .255" h)

CENTER-TAPPED DC ISOLATED PRIMARY & SECONDARY

Model No.	Imped. ratio	Freq. (MHz)	Price (10-49)
T1-1T	1	.05-200	$3.95
TM01-1T	1	.05-200	$6.45
T2-1T	2	.07-200	$4.25
TM02-1T	2	.07-200	$6.75
T2.5-6T	2.5	.01-100	$4.25
TM02.5-6T	2.5	.01-100	$6.75
T3-1T	3	.05-250	$3.95
TM03-1T	3	.05-250	$6.45
T4-1	4	.2-350	$2.95
TM04-1	4	.2-350	$4.95
● T4-1H	4	8-350	$4.95
T5-1T	5	.3-300	$4.25
TM05-1T	5	.3-300	$6.75
T13-1T	13	.3-120	$4.25
TM013-1T	13	.3-120	$6.75

DC ISOLATED PRIMARY & SECONDARY

Model No.	Imped. ratio	Freq. (MHz)	Price (10-49)
T1-1	1	.15-400	$2.95
TM01-1	1	.15-400	$4.95
● T1-1H	1	8-300	$4.95
T1.5-1	1.5	.1-300	$3.95
TM01.5-1	1.5	.1-300	$6.75
T2.5-6	2.5	.01-100	$3.95
TM02.5-6	2.5	.01-100	$6.45
T4-6	4	.02-200	$3.95
TM04-6	4	.02-200	$6.45
T9-1	9	.15-200	$3.45
TM09-1	9	.15-200	$6.45
● T9-1H	9	2-90	$5.45
T16-1	16	.3-120	$3.95
TM016-1	16	.3-120	$6.45
● T16-1H	16	7-85	$5.95

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Model No.	Imped. ratio	Freq. (MHz)	Price (10-49)
T2-1	2	.025-600	$3.45
TM02-1	2	.025-600	$5.95
T3-1	3	.5-800	$4.25
TM03-1	3	.5-800	$6.95
T4-2	4	.2-600	$3.45
TM04-2	4	.2-600	$5.95
T8-1	8	.15-250	$3.45
TM08-1	3	.15-250	$5.95
T14-1	14	.2-150	$4.25
TM014-1	14	.2-150	$6.75

FOR ADDITIONAL INFORMATION, COMPLETE SPECIFICATIONS, AND PERFORMANCE CURVES, REFER TO 1979-80 MICROWAVES' PRODUCT DATA DIRECTORY pgs. 161 to 368 or 1979 EEM 2770 to 2974.

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CIRCLE NO. 5

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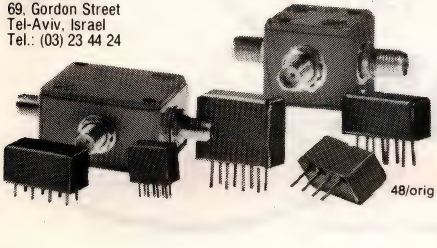


48/orig

Letters

Use connector with LED displays—not LCDs

Your product feature on our new series of elastomeric connectors (April 12, 1980, p. 248) correctly stated that the HL Type connector is a low-resistance connector.

For this reason, it is *not*, as your article states, recommended for use in highly resistive LCD circuits.

The HL Type will carry relatively high currents up to 80 mA at 80 F when connected to .035-in. Au electrodes. It is recommended for almost all low-resistance circuits, including LED and gas-discharge displays.

The HL type elastomeric connector is also recommended for board-to-board connections and for connecting LSI and VLSI packages to boards.

Laurette M. Bennette, General Manager
Conductive Rubber Technology
Olive Mill Plaza
1230 Coast Village Circle
Santa Barbara, CA 93108

Window comparator needs a change

The March 29 Idea for Design, "Two Op-Amp Window Comparator Needs No Decoding" (p. 113) has an error.

The resistance values for R_1 and R_3 are interchanged. To fix it, change the R_3 value to 2.32 k and the R_1 value to 1.07 k.

John Volanski, Engineer
General Dynamics
Electronics Div.
P.O. Box 81127
San Diego, CA 92138

Errata

Some errors crept into "LEDs or DLs: Which Light Source Shines Brightest in Fiber-Optic Telecomm Systems?" (April 12, 1980, p. 131):

- In Fig. 1, the curves should be labeled (left-to-right) 20 C, 20 C, 35 C, 50 C, 65 C.
- The third entry of the table (p. 133) is "Quartz & Silice."
- In Fig. 6, the ordinate axis should read "Optical Power (μW)."
- In the second paragraph under the subhead "LEDs may have a deceiving output" (p. 134), the fiber-core diameter mentioned should be 62 μm.
- Lines 2 and 3 at the right-hand top of p. 135 should read . . . "τ_{Tj} is the MTBF at T_j; τ_{To} the extrapolated MTBF at T_o;. . ."

Nanovoltmeter's even better than described

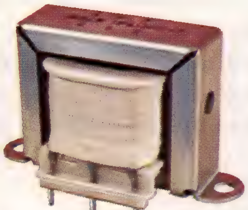
We at Keithley were quite pleased to find our Model 181 digital nanovoltmeter selected as a spotlight feature in the Electro '80 Products section of the April 26 issue (p. 107). Unfortunately, the article contained some inaccurate information we'd like to clarify:

- The 181 responds to a step change incredibly fast, settling to within 25 digits of final value or 0.0125% of full scale in 0.5 second (not 30 seconds).
- The 181 offers 11 decades of voltage span, from 10 nV to 1000 V (not seven decades or 2000 V).

(continued on page 16)

Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Editor, Electronic Design, 50 Essex St., Rochelle Park, NJ 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld upon request.

Stepped-up vitality



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CIRCLE NO. 8

Meetings

International Conference on Communications, June 8-11. Red Lion Inn, Seattle, WA. IEEE, 345 E. 47 St., New York, NY 10017.

International Symposium on Electrical Insulation, June 9-11. Howard Johnson, 57 Park Plaza Hotel, Boston, MA. IEEE.

DATACOMM International Mini/Microcomputer, Microprocessor Exposition, June 17-19. Palais des Expositions, Geneva, Switzerland. ISCM, 222 W. Adams St., Chicago, IL 60606.

Power Electronics Specialists Conference (PESC), June 17-19. Dunfey Atlanta Hotel, Atlanta, GA. IEEE.

Chicago Spring Conference on Consumer Electronics, June 18-19. Arlington Park Hilton, Arlington Heights, IL. IEEE.

International Quantum Electronics Conference, June 23-26. Sheraton-Boston Hotel, Boston, MA. IEEE.

Conference on Precision Electro-Magnetic Measurements, June 23-27. Stadthalle, City of Braunschweig, Federal Republic of Germany. IEEE.

Power Systems Monitoring and Control International Conference, June 24-26. London, England. IEEE.

Power Engineering Society Summer Meeting, July 13-18. Radisson Hotel, Minneapolis, MN. IEEE.

Nuclear and Space Radiation Effects Conference, July 15-18. Cornell Univ., Ithaca, NY. IEEE.

Quartz Crystal Conference, Aug. 12-14. Radisson Muehlebach Hotel, Kansas City, MO. K-N Enterprises, Inc., 630 S. Rogers Rd., Olathe, KS 66061.

Intersociety Energy Conversion Conference, Aug. 18-22. Olympic Hotel, Seattle, WA. IEEE.

Engineering in the Ocean Environment, Sept. 8-10. Olympic Hotel, Seattle, WA. IEEE.

International Congress on Transportation Electronics, Sept. 15-17. Hyatt Regency, Dearborn, MI. IEEE.

European Solid-State Device Research Conference (ESSDERC '80), Sept. 15-18. University of York, York, England. IEEE.

Optical Communication European Conference, Sept. 15-19. University of York, York, England. IEEE.

Electromagnetic Compatibility, Conference, Sept. 15-19. University of Southampton, Southampton, England. IEEE.

International Symposium on Subscriber Loops and Services (ISSLS '80), Sept. 15-19. Bayericheoss, Munich. IEEE.

International Fiber Optics and Communications Exposition, Sept. 16-18. Hyatt Regency, San Francisco, CA. Information Gatekeepers, Inc., 167 Corey Rd., Suite 111, Brookline, MA 02146.

Western Electronic Show and Convention (WESCON), Sept. 16-18. Anaheim Convention Center, Anaheim, CA. IEEE.

Broadcast Symposium, Sept. 17-19. The Washington Hotel, Washington, DC. IEEE.

3 Times
Actual Size

LOW COST!

High Speed Planar PIN Photodiodes

New inexpensive TRW Optron devices offer high sensitivity, low noise and fast response for applications where space and cost are critical.

TRW Optron's new OP 905 and OP 915 high speed silicon planar PIN photodiodes are especially designed for applications requiring high sensitivity, low noise and fast response where space and cost are critical.

Both new TRW Optron devices have an active area of 7.5 mm² and are available in a small, low cost plastic package ideal for use where space is at a premium. The package design simplifies mounting on a printed circuit board, and the devices can be positioned side by side in close proximity to form multielement arrays.

ACTUAL SIZE

Sensitivity of the photodiodes is typically between 0.55 and 0.65 amp/watt at peak sensitivity of 800 nm for the OP 905 and 920 nm for the OP 915. The spectral sensitivity range of 400 nm to 1200 nm makes the devices ideal for visible or near infrared applications.

Each device is suitable for operation in either the photodiode or photovoltaic mode. At a bias of 10 volts, the OP 905 has a junction capacitance of 60 pf and a response time of 200 nsec with a 1 KΩ load resistance. Under similar conditions the OP 915 has a capacitance of 15 pf and response time of 50 nsec.

Detailed technical information on these new high speed silicon planar PIN photodiodes and other TRW Optron optoelectronic products is available from your nearest TRW Optron sales representative or the factory direct.

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CIRCLE NO. 9

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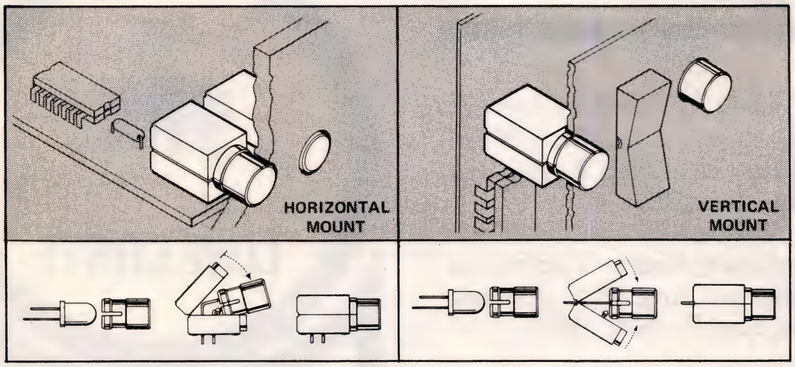

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CIRCLE NO. 10

(continued from page 13)

- The price of the 181 is $2490 (not $1995), and this includes a built-in IEEE-488 interface and the isolated analog output.
- Delivery takes 90 days (not 60).

Keithley's Model 148, which measures 1 nV, was introduced 16 years ago. To the best of our knowledge, no other U.S. manufacturer has ever matched our 30-nV peak-to-peak noise specification in a nanovoltmeter—let alone one like the 181, which was designed and specified as a 5-1/2-digit instrument and has 6-1/2-digit resolution.

Roger Betz
Public Relations Manager
Keithley Instruments, Inc.
28775 Aurora Rd.
Cleveland, OH 44139

Oops!

Datel-Intersil's latest 4-1/2-digit panel meter is indeed a compact instrument, but its display is not minuscule. Our product feature in the April 26 issue (p. 119) should have given the digit height as 0.3 in. Also, the correct model number is DM-4100D.

Oscillator mixup

Somehow, we mixed up our oscillators in the special report on counters appearing in the April 26 issue (p. 71). The function of the HP startable-lockable, phase-lockable oscillator described on p. 76 is to correct for the usual ±1-count error. It has no function in the time base.

Sorry, wrong number

On p. 86 of the April 12 issue, the phone number for Avanti Communications was in error. The correct number is: (401) 849-4660.

NO. 12

NATIONAL ANTHEM

SEMICONDUCTOR NEWS FROM THE PRACTICAL WIZARDS OF SILICON VALLEY.

National emerges as the logical choice for memory.

HIGH QUALITY RAMs NOW AVAILABLE IN ALL SPEED RANGES.

Data acquisition rethought

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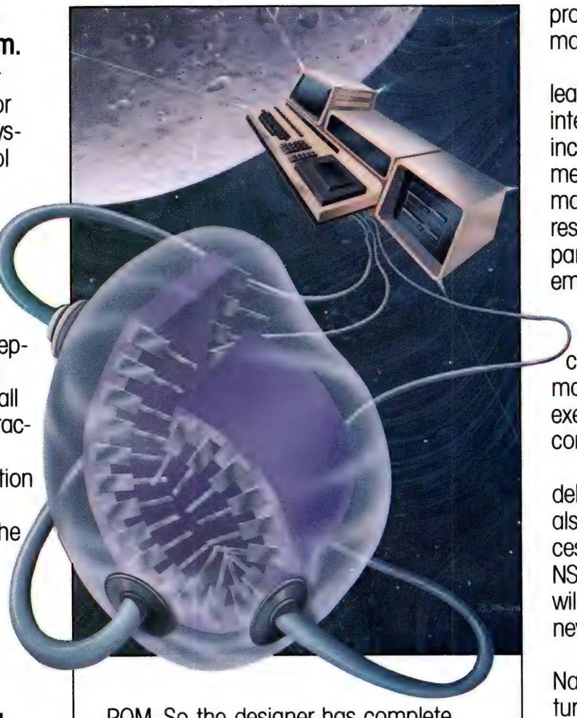
NATIONAL ANTHEM

STARPLEX™ aids μP system development.



STARPLEX with ISE,™ the fully developed development system.

Using the STARPLEX development system with National's 8048 Emulator Package, designers of 8048 Family systems get the kind of sophisticated tool needed for efficient microcomputer development.

And with 8048 ISE (In-System Emulator), they get capabilities that up to now simply haven't been available in this type of instrument.

What is ISE? National's ISE is a separate STARPLEX module housing 32K bytes of real-time map memory, plus all the necessary logic for breakpoints, tracing, and memory mapping. These resources are available for the emulation of several different μPs. Because the individual emulator target cards are the only components dedicated to particular processors.

And since ISE doesn't share the STARPLEX BUS, the system doesn't have to compete for memory access with its STARPLEX host.

ROM display and disassembling. The 8048 emulator package provides capabilities which zero in on the problems of designing with single-chip microcomputers. The target card has its own 4K of RAM dedicated to the real-time emulation of the processor's program ROM. So the designer has complete access to this memory throughout emulation.

He may examine and disassemble existing ROM contents, make changes, and execute the altered code. This gives him considerable flexibility in new product design, as well as previously masked 8048.

Look into our ISE. National's easily-learned ISE software comes completely integrated into the STARPLEX system, including an "In-File" mode that will implement a predefined sequence of commands. And ISE can also record those results, so you can see exactly how each part of the system operated during the emulation sequence.

ISE's program control capability provides not only the usual breakpoint conditions, but also a "coast" command which allows you to continue executing a program after the breakpoint combination has been satisfied.

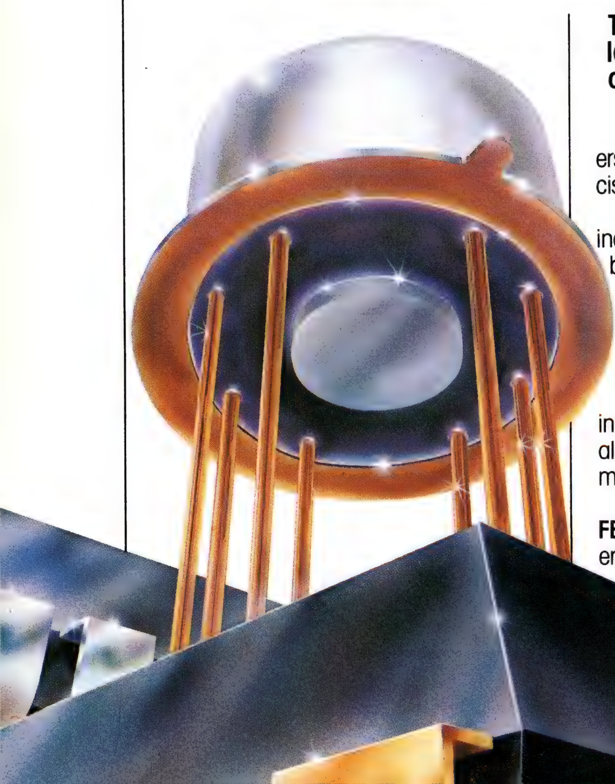
STARPLEX can not only develop and debug software for the 8048 Family, but also for 8080 and Z-80® microprocessors plus BLC/SBC Series 80 boards. NSC800, 8070 and other ISE packages will of course become available as these new processors are introduced.

When you get right down to it, National's STARPLEX with ISE offers features not available in any other development system on the market today. Yet it costs substantially less to own and operate than any system currently being sold.

Practical Wizardry strikes again.

STARPLEX and ISE are trademarks of National Semiconductor Corporation. Z-80 is a registered trademark of Zilog Corporation.

The LM11. A dramatic advance in op amps.



This new op amp represents the largest single advance in bipolar op amp design in over a decade.

National again drives home its leadership in linear with the new LM11 precision DC amplifier.

Designed by Bob Widlar, the LM11 incorporates the best features of existing bipolar designs – and then some:

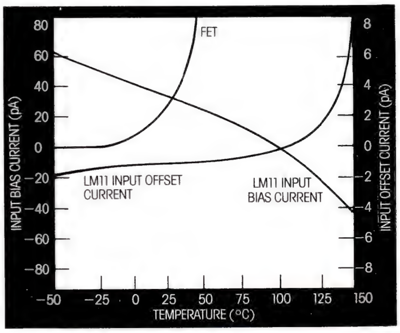
50pA input bias current (max)
10pA input offset (max)
300μV offset voltage (max)
3μV/°C drift (max)

As shown in the graph, the LM11's input bias current is not only very low, it also remains well behaved over the entire mil-temperature range.

An order of magnitude better than FETs. Overall, the new LM11 reduces DC error terms to such an extent that the op amp is no longer the limiting factor in many practical designs. Especially over the mil-temp range.

Further, its offset voltage, drift and long-term stability are an order of magnitude better than FETs.

Although internally compensated with provision for offset balance, the new LM11 is pin-compatible with, and quite similar to, the well-known LM108A amplifier.



Leakage current only affects input current of the LM11 above +125°C.

Linear Data Book tops National bestseller list.

National announces the new 1980 Linear, Voltage Regulator and Audio data books. And until Labor Day, they're all yours for $15* complete.

National, the long-time Linear leader, is also known for their clear, concise and comprehensive data books. And the 1980 books are certainly no exception to the rule.

Their 1980 Linear Data Book, the analog designer's "right-hand man," gives you over 1200 pages packed with useful, up-to-date information on National's broad line of Linear components. (The broadest line in the industry.)

And until Labor Day, you can add this perennial bestseller to your reference library for only $6.00 ($3.00 off the regular price).

The package deal. National is also offering a special package deal on a set of three valuable references. No technical library would be complete without them.

And between now and Labor Day, National will sell you three of their best-selling 1980 books – Linear, Voltage Regulator and Audio – for only $15.00 complete. That's a full $6.00 off the regular selling price.

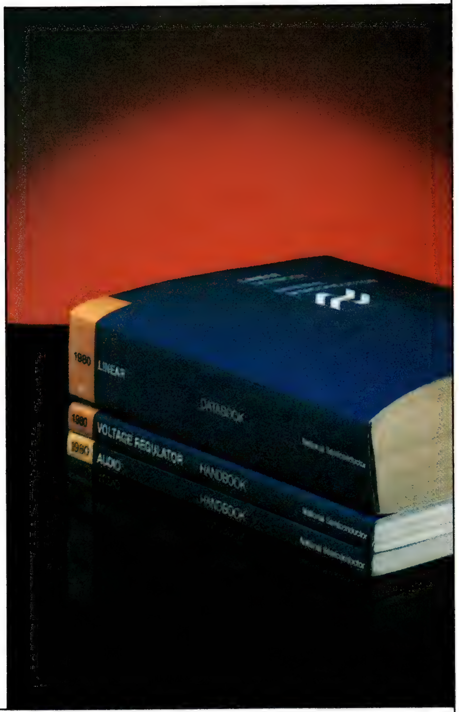
The 1980 Voltage Regulator Handbook covers power supply and regulator design all the way from the transformer to the heat sinks.

The 1980 Audio Handbook presents – in a single volume – real-world design approaches plus the more exotic audio subjects (such as pickups, phase splitters, fuzz, reverb, etc.).

To get your copies, simply fill out and send in this issue's National Archives coupon. Please indicate the quantities desired and include a check or money order for the appropriate amount.

All orders postmarked by Labor Day – September 1 – will qualify for this special offer, so don't delay.

*Prices shown are U.S. prices only.



Nationally improved memories.

By substantially increasing their production capacity, National is meeting the demand for high-quality 16K dynamic RAMs.

National Semiconductor has made a major commitment to the high-density RAM marketplace by significantly stepping up their production capacity.

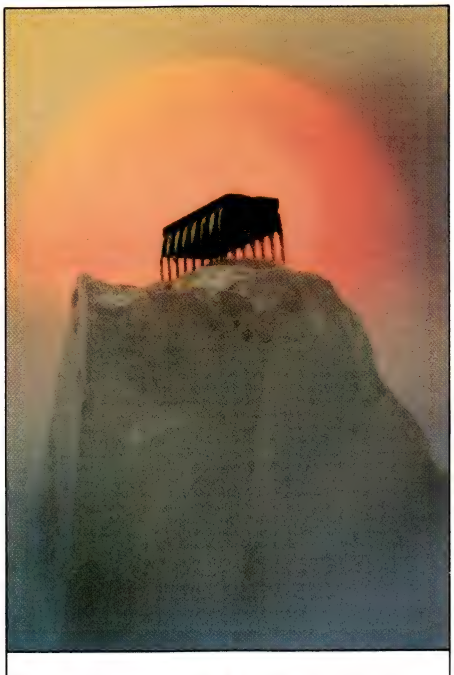
As a result, their competitively priced MM5290 16K dynamic RAMs are available in production quantities right now through your National distributor or sales representative. (Call for pricing information.)

And with their exclusive combination of design and manufacturing procedures, the MM5290s are setting new industry standards for quality and reliability.

For example, the popular MM5290 Family is designed so that soft errors induced by stray alpha particles are virtually eliminated.

This, combined with National's extensive component test procedures, assure unsurpassed operational integrity and dependability in every high-speed, high-density RAM application.

← Don't miss the important news inside.



The first and only MST.™ In addition to National's use of conventional final testing and QA component level processing, many customers request National's unique MST (Memory Systems Test) program.* MST eliminates or greatly reduces the customer's own requirements for internal testing. So their incoming test, board test and system rework costs are substantially reduced.

For more detailed information about MST and the MM5290 Family – plus a Reliability News Brief on alpha particle test results – be sure to check the National archives coupon below.

Quality RAMs from a quality source. National has, of course, been known as a quality production house for a long time.

And now they've made an unprecedented full-force commitment to the RAM marketplace. A commitment proven by the industry's most advanced design, fabrication and testing techniques.

And thanks to their unmatched production capacity, this kind of quality in every kind of RAM is now even easier to get than you ever thought possible.

From start to finish, the Practical Wizards from National are doing more and more to meet all your memory needs.

*Patent pending.

MST is a trademark of National Semiconductor Corporation.

Practical Wizardry – a means toward new beginnings.

Practical Wizardry.

A catchy phrase, but what does it really mean? Is it an end in itself? Or is it a beginning?

To answer these questions, consider some of the most outstanding personal examples of practical wizardry – the works of Sir Isaac Newton.

Newton's brilliance came from his uncanny insight into common, everyday phenomena. The swinging of a pendulum. Gravitational attraction. Terrestrial mechanics. The spectral properties of sunlight.

And when he needed to go further than simple algebra could take him, he opened up a whole new realm of mathematics called calculus – one of the most fundamental beginnings of modern technology.

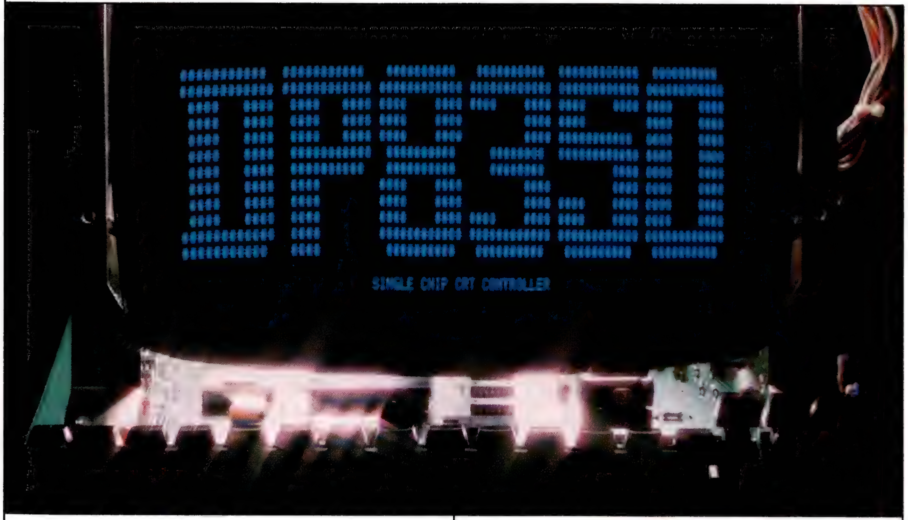
In fact, if it wasn't for Newton, today's technological renaissance may never have happened.

And when you think about it, today's practical wizards really aren't very different. Although their efforts are more specialized, their contributions to today's society are every bit as useful and significant as Newton's were to his.

At National Semiconductor, practical wizardry is much more than just a catchy phrase – it's our lifes' work. A means toward new beginnings.

By following the examples set by Newton and dozens of other practical wizards of the past, we're finding the most useful and workable solutions for today's needs.

Major CRT makers demand ultimate controller.



National's DP8350 Series of single-chip CRT controllers form the heart of over 60 terminal designs worldwide.

Over 50 major CRT terminal manufacturers from around the world have discovered the industry's only complete, single-chip CRT controllers.

National Semiconductor's powerful line of CRT controllers – the DP8350 Series – requires considerably less support circuitry than any other controller on the market.

Due in part to their bipolar (I^2L) circuitry, the DP8350 Series is widely regarded as the ultimate in CRT display refresh circuits.

Single-chip versatility. The 40-pin DP8350 Series – which includes the DP8350, DP8352 and DP8353 controllers – offers a full range of features using internal mask programmable ROM.

Since the need for a microprocessor interface has been eliminated, overall system design is greatly simplified.

The versatility inherent in the DP8350 Series cannot be understated. In the character field, for example, both the total number of dots per character field and the number of scan lines per character may be specified (up to a 16 x 16 dot matrix). The number of characters per row (from 5 to 110) and character rows per video frame (from 1 to 64) may be specified as well.

Doing more for less. The popular DP8350 Series does more to lower your system costs than any other single component. And since it requires so little in the way of support circuits, the engineer can spend much more time (and board space) on the more demanding aspects of the product design.

It's no wonder that the DP8350 is at the heart of the best designs. The industry certainly knows a winner when it sees one.

LH0082 fiber optic receiver amp lightens the load.

National now in fiber optics with versatile high-speed interface.

National has good news for anyone designing commercial fiber optic applications. Their new LH0082 general purpose receiver amp eliminates the cost and hassle of building your own high-speed amplifier. But there's more. The LH0082 not only expedites development, it also improves performance while allowing an unprecedented degree of design flexibility.

All you need, all in one. The self-contained LH0082 requires only a single 5V to 12V power supply. So it can act as the interface between all of the most popular photodetectors and any standard logic family or any analog circuit.

The LH0082 transimpedance amp also features a 2GHz gain bandwidth, excellent sensitivity (to 30nW), data rates up to 50Mbps, and high immunity to noise in a fiber optic environment. All hermetically sealed for reliability in a standard 14-pin DIP.

The possibilities are endless. National's new LH0082 lends itself perfectly to fiber optic communications both guided and broadcast. It can, for example, be used for computer interfaces with peripheral devices, word processing systems, remote graphic terminal data links, and point-of-sale data links.

The LH0082 is also ideal for industrial control devices, robotics, telecommunications on T1, T2, or T3 carriers, as well as airborne and shipboard multiplex communication and control systems.

And to top it off, all of this performance is now available at a surprisingly low cost.

When you come right down to it, it's no surprise that National would be the first to offer a truly versatile necessity to the fiber optic designers. After all, that's what Practical Wizardry is all about.

AF100 active filters–a universal solution to cost problems.

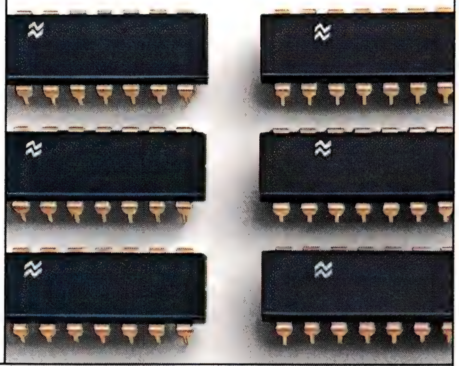
In the past, the easiest and least expensive means of active filtering was with discretes. But this is no longer the case thanks to National's new AF100 universal active filters.

The AF100s are internally adjusted to provide center frequency accuracies of ±2.5% (for the AF100-1CN model) and ±1% (for the AF100-2CN model).

And because of their small size and low external parts count, the AF100 active filters lend themselves perfectly for use in MODEMs and many other telecommunications applications that require lowpass, highpass, or bandpass filter configurations.

But there's more to the price/performance story than just design versatility and decreased manufacturing costs. The AF100 universal active filters are attractively priced as well.

Just another example of Practical Wizardry cutting your costs to the bone.



"National is your best choice for Custom MOS/LSI because we planned it that way."

"What does it take to become the best? At National Custom MOS/LSI, it took good planning – and the solid resources of a billion-dollar company to back it up.

"We're certainly proud of being the best and we have every intention of staying that way. Because we've got something that no other single supplier can offer: the bigness of a Fortune 500 corporation and the smallness of a personal staff of design wizards dedicated to your application.

"On one hand we're large enough to find the best solution to your particular needs in the shortest amount of time. Even if the answer lies in standard component designs National's broad-based product line has you covered.

William Sanderson, Group Marketing Manager, Custom MOS/LSI.

"Yet on the other hand, we're small enough that we can work in close technical partnership with your own engineering staff to develop an exciting new and exclusive product. Whether it stems from a list of specs or an existing standard component design.

"It takes good, sound business practices to develop a high-quality operation like this.

"From design and development, all the way through fabrication and assembly, and on to delivery, you're assured of getting the best there is in Custom MOS/LSI.

"Because at National, planning for your success is a never-ending process."

National's new BLC-8715 – a more intelligent approach to data acquisition.

High-speed intelligent I/O board offloads analog pre-processing functions from the data acquisition system CPU.

National announces a bright new addition to its family of Series 80 Board Level Computers: the BLC-8715 Intelligent Analog Input Board.

The BLC-8715 was specifically designed for industrial data acquisition and process control systems. This new microprocessor-based interface offloads all of the analog data pre-processing functions normally performed by the host CPU.

And in doing so, the CPU may then devote more of its valuable resources to the rest of the control system.

Faster than a speeding digit. Besides freeing up host system resources for more demanding tasks, there are many reasons why the rugged BLC-8715 smooths out process control.

One of the most dramatic is its A/D conversion speed. Based on National's proven BIFET™ technology, the 8-bit BLC-8715 Analog Input Board performs the A-to-D conversion in a scant 8μsec.

More versatility than ever before. The BLC-8715 performs "front end" measurement and control functions for 16 analog processes. But that's not all.

It also features 22 digital (TTL-compatible) lines for controlling simple on/off equipment functions, digital readouts, and even manual keyboard override systems.

And to further increase the board's versatility, the Practical Wizards at National designed it so that it may be configured in either of two ways.

By using its standard RS232C interface, the BLC-8715 becomes a remote "slave" to the CPU host.

However, the intelligent I/O board can also interface directly with the host system bus. One of the many benefits of this approach is the BLC-8715's Mailbox memory: 265 bytes of RAM that are directly addressable by any intelligent device on the bus.

It certainly comes as no surprise that National should be the first to take a more intelligent approach to data acquisition and process control.

After all, that's what Practical Wizardry is all about.

BIFET is a trademark of National Semiconductor Corporation.

What's new from the National Archives?

005 ☐ Additional Custom MOS/LSI Information
006 ☐ Special Functions Data Book ($6.00 ea.)
015 ☐ MST Program Brochure
024 ☐ DP8350 Series Data Sheet and Application Notes
026 ☐ AF100 Data Sheet
031 ☐ LH0082 Data Sheet
034 ☐ LM11 Data Sheet and Application Note
035 ☐ Additional Series/80 Information
036 ☐ Optoelectronics Handbook ($3.00 ea.)
037 ☐ Additional STARPLEX and ISE Information
038 ☐ MM5290 Data Sheet and Additional Information
039 ☐ BLC-8715 Data Sheet
044 ☐ 1980 Linear Data Book only ($6.00 ea.)* qty_____
046 ☐ 1980 Data Book Package (3 books; $15)* qty_____
TOTAL $_____

*Prices effective until September 1, 1980

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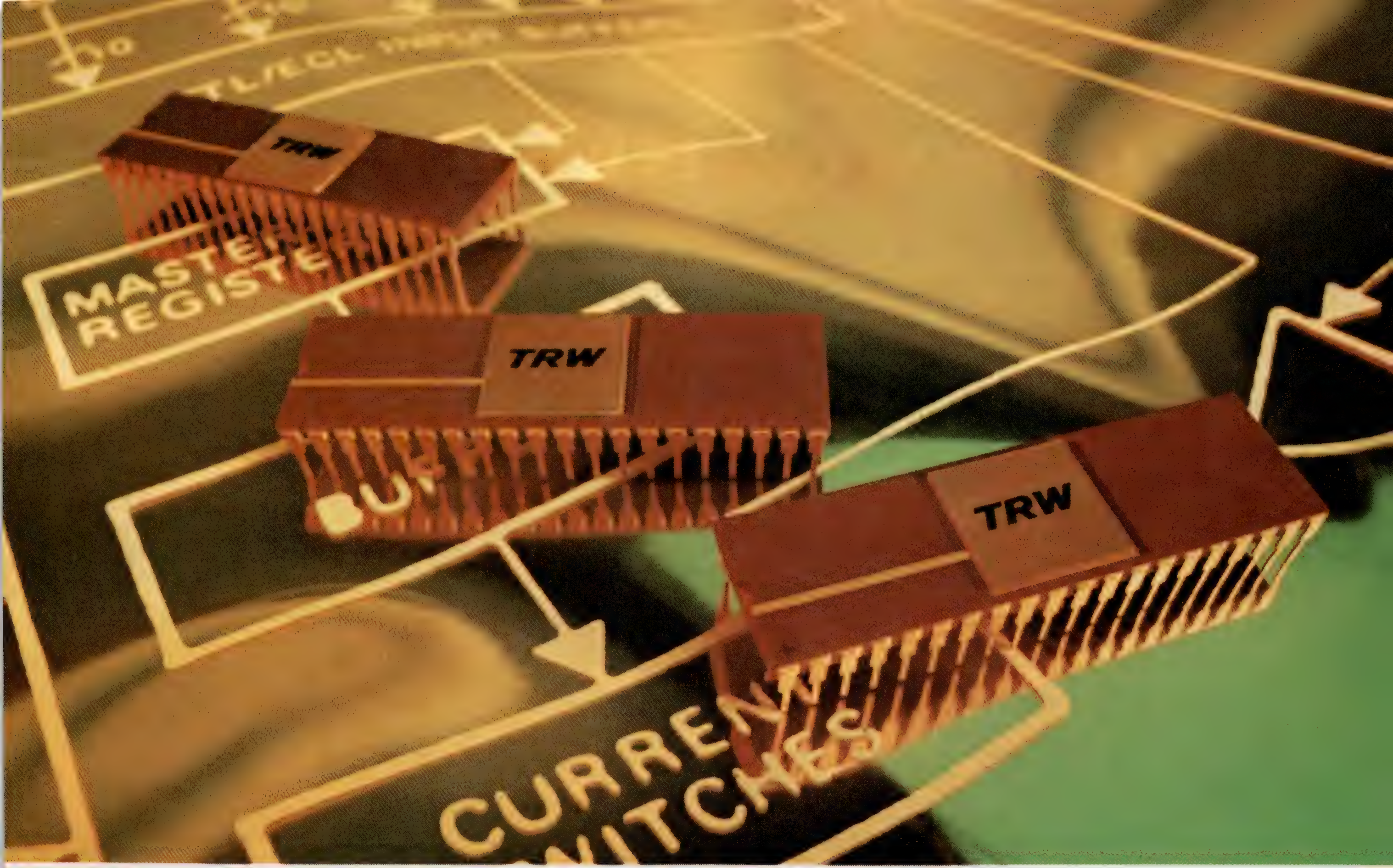

Now! 20 MHz monolithic 10-9-& 8-bit D/A converters

(And they're glitchless.*)

Only TRW offers you all these features in a DAC.

Signal conversion is a guaranteed 20 megasamples/sec. Best rate yet for a monolithic 10-bit DAC.

*Glitches are barely measurable. Less than 100 picovolt-second on average. An internal input register and equalized delay circuitry eliminate the need for any external deglitching components.

Our DACs are compatible with TTL and single-ended or differential ECL. And handle a variety of inputs: 2's complement, inverted 2's, or binary.

A unique output clocking option offers the ability to zero the output at any time. It can be strobed with an independent clock. A 1V/75 ohm output directly drives a load without an op amp or buffer. For convenience, we included a Force High/Force Low control for calibration. It gives you full scale or zero output without changing the digital input. Physically, our monolithic/bipolar DACs in their 40-pin DIP demand less. They take up less space and require only 600 mW (vs. 2-5 watts for module types).

The new DACs from TRW: they leave no reason to delay going monolithic. Not even price.

These high-speed high-resolution D/A converters are in stock at Hamilton/Avnet.

D/A Converter	Resolution (Bits)	Speed (MSPS)	Power (Watts)	Unit Price (in 100s)**
TDC1016J-10	**10**	**20**	**0.6**	**$98**
TDC1016J-9	**9**	**20**	**0.6**	**$51**
TDC1016J-8	**8**	**20**	**0.6**	**$38**

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CIRCLE NO. 11

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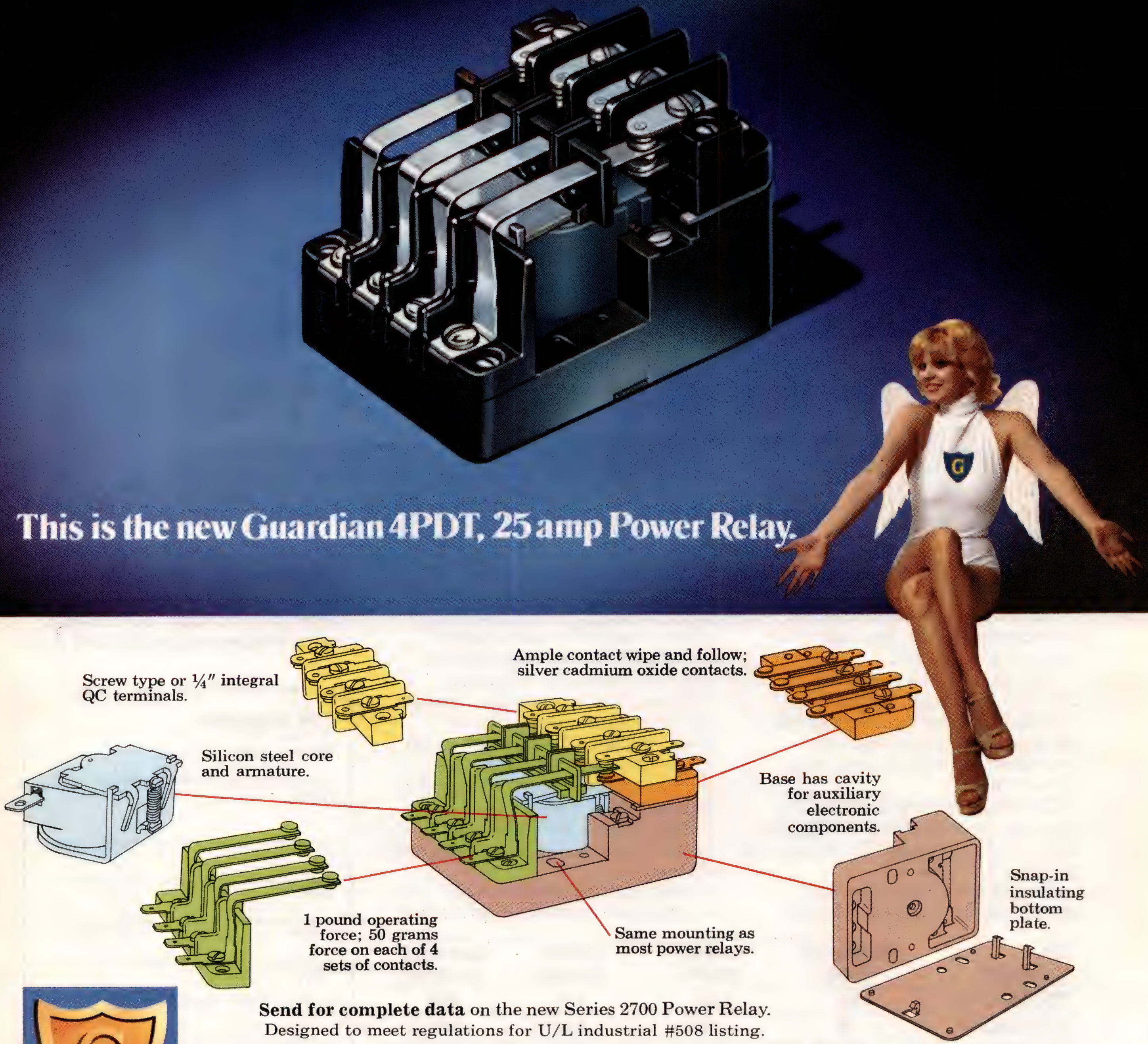
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CIRCLE NO. 12

LateNews

PCM filter chips handle one function—filtering or receiving

Monolithic PCM filters serving one function—transmitting or receiving—are coming from Siliconix (Santa Clara, CA). Separating the filters should provide the low intrachannel crosstalk levels needed in nonswitching equipment such as channel banks. One major feature is an on-chip phase-locked loop that develops the clocking for the switched-capacitor sections from the 8-kHz sampling clock of the associated codec.

Siliconix expects the new chips to outperform other IC filters in the areas of ripple, bandwidth and noise. Once the noise problem abates, telecomm-equipment manufacturers should get a better handle on crosstalk, much of which is often masked by noise. Samples are expected in August, volume production is slated for the fourth quarter.

ISO/CMOS parts bring bipolar speed at a fraction of the power

Using a proprietary process, Mitel (Ottawa, Canada) has come up with a CMOS-based alternative to power-hungry bipolar interface circuits—a family of replacement circuits for low-power Schottky 74LS TTL. Propagation delays are about the same as those of the LS TTL parts, but the new "ISO/CMOS" parts will consume nearly 100 times less power. Initially, about 20 circuits will be introduced, including one-of-eight decoders, buffers, transparent latches, flip-flops and transceivers.

Two hybrids make complete data-acquisition system

High-reliability applications will soon have a complete data-acquisition system from Harris Semiconductor (Melbourne, FL). Two hybrid sections make up the system: the HI-5900 analog signal processor and the HI-5712 12-bit successive-approximation converter. The HI-5900 includes a programmable-gain amplifier, an eight-channel multiplexer, and track-and-hold circuit, and will be available as a hybrid circuit in a 32-pin ceramic DIP. The HI-5712, which offers 8-μs conversion time and nonlinearity within ±1/2 LSB, includes a precision reference (HA-1610), a 12-bit DAC (HI-562), a 100-ns comparator (HA-4950) as well as a clock, a successive-approximation register, three-state latches—all in a 40-pin ceramic DIP package.

Card converts daisy-wheel printer to word processor

Word-processing power can be added to a daisy-wheel printer by inserting a printed-circuit card. With a Wilker, Inc. Model DB2000, a Z80-based card with a 2-kbyte buffer, the printer can perform line justification, proportional spacing, both full-page as well as dual-column line justification, centering of words or complete paragraphs, and all other common word processing functions. At present, the board converts the Qume, Diablo, and Dataproducts printers, while a future version will support the NEC Spinwriter printer.

Test-point analyzer uses software control

High-voltage solid-state relays and a computer controller combine in a new test-point analyzer to allow test voltages up to 300 V and programmable switching of up to 64,000 test points. Mechanical relays and hard-wired algorithms formerly associated with test point analyzers are eliminated. The TA-9 analyzer from Trade Instruments (Canoga Park, CA) uses computer controlled switching, dubbed crosspoint, implemented by 4-terminal SSRs that allow the switching matrix to be software-configured on-the-fly. According to Trace, the Crosspoint switches have lower on-resistance than conventional SSRs, which permits more accurate measurements to be made in automated testing applications.

Typical test times, based on a standard algorithm, are approximately 400 ms for a 1000-point test and 7 s for a 10,000-point test. The system is expandable from 32 to 64,000 test points in 32-point increments, and the switching cards are designed to be compatible with existing Trace systems.

Speedy ADC modules tighten differential nonlinearity

Two fast a/d converter modules with extra-tight differential nonlinearity are on the way from the Computer Labs Division of Analog Devices (Greensboro, NC). The MAH-0801 8-bit successive-approximation a/d converter does its job in less than 750 ns with a maximum nonlinearity of ±1/2-LSB, and ±1/8 LSB typical. The MAH-1001 10-bit converter operates to ±1/2-LSB maximum nonlinearity within 1 μs. The MAH-0801 module is pin-compatible with converters like Teledyne Philbrick's 4130, and Datel-Intersil's ADC-G8, while the MAH-1001 is compatible with the 4131 or ADC-G10.

IEEE-488-based Apples control instruments or processors

Two small computer systems that feature the IEEE-488 bus for instrumentation and intraprocessor controls are coming from Apple Computer, Inc. (Cupertino, CA). Both Apple III systems will emulate the Apple II but will be packaged differently. One Apple III, called the Information Analyst ($4000), includes a 6502A-based processor, an 80-character keyboard, enhanced color graphics, and a 5-1/4-in. floppy-disk drive. It also supports Basic and Pascal. For $4700, the second Apple III will specialize in word-processing applications. But for better print quality—and about $8000—the system will attach to a Qume or Diablo printer.

Late Briefs

Apparently, Texas Instruments has gained another ally for its ALS TTL logic family —Motorola. The Phoenix, AZ company will soon begin sampling its first ALS units. At this time, however, Motorola has not committed itself to AS products since its 10k ECL family offers slightly higher performance....Speaking of higher performance, **Motorola will shortly unveil the 10kH family of ECL circuits.** Though totally 10k-compatible, these circuits will also feature a 50% reduction in propagation delays via the company's new oxide-isolated process, Mosaic....No sooner did ITT Cannon introduce its part of the HDC interface system (p. 65) than it **significantly improved the methods of installing the terminated DuPont cable in the diode housing.** A separable snap-in ferrule allows the diode/connector body assembly to be wave-soldered to the board before the fiber-optic cable is installed—this precludes any possibility of heat damage to the cable. Then a two-piece metal-ferrule assembly is connected to the cable and snapped into the connector housing holding the Spectronics diode. Other improvements will follow, according to ITT Cannon....Systron-Donner (Concord, CA) introduced its Model 2450 Frequency Response Analyzer at Electro '80. **The frequency-domain dynamic analyzer, with interactive keyboard and IEEE-488 compatibility for ATE applications,** will be built in the United Kingdom by SE Labs, a fellow member of the Thorn EMI Group. The unit also analyzes and computes transfer functions statistically as well as dynamically....Rockwell International (Anaheim, CA) is beefing up the support for its AIM-65 microcomputer system with its Microflex family, which includes a module adapter, a four-slot piggyback cage for the AIM, a buffer card, a PROM programmer and four other support cards. Two of the support cards are memory modules, with capacities of 8192 bytes of RAM or 16 kbytes of PROM/ROM. The other two cards are an extender board and a prototyping module.

NEW STARS IN THE EXPANDING HEXFET™ UNIVERSE!

Revolutionary HEXFET technology now in medium power MOSFETs.

Off-the-shelf delivery at down-to-earth prices!

The ratings of six smaller but no less brighter new stars in the ever-expanding HEXFET line are highlighted in the table below.

This advanced set of medium power transistors features a new die size created to provide HEXFET technology and the established MOSFET design advantages of voltage control, ease of paralleling, freedom from second breakdown and ultra-fast switching at record low costs.

For example, the 1000 piece price for the 100V IRF520 is only $5.95, and the 400V IRF720 is just $6.30. At such low prices, chances are these new TO-3 or TO-220AB HEXFETs can make MOSFET advantages affordable for your application.

We're not a bit starry-eyed about delivery. All HEXFETs listed in the table are available NOW . . . from us or from in-depth stock of an IR Distributor near you.

Contact us, an IR Sales Office or Rep for Tech Data, today. HEXFETs will do a stellar job for you tomorrow!

VOLTAGE RATING	TO-3 PACKAGE			TO-220 PACKAGE	
100	IRF120 6 Amps	IRF130 12 Amps	IRF150 28 Amps	IRF520 5 Amps	IRF530 10 Amps
200	IRF220 4 Amps	IRF230 7 Amps		IRF620 3.5 Amps	IRF630 6 Amps
400	IRF320 3 Amps	IRF330 4 Amps	IRF350 11 Amps	IRF720 2.5 Amps	IRF730 3.5 Amps
500		IRF430 3.5 Amps			IRF830 3 Amps

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CIRCLE NO. 13

THE 12-BIT ADC

OUR AD574 IS THE OVERALL PERFORMANCE WINNER.

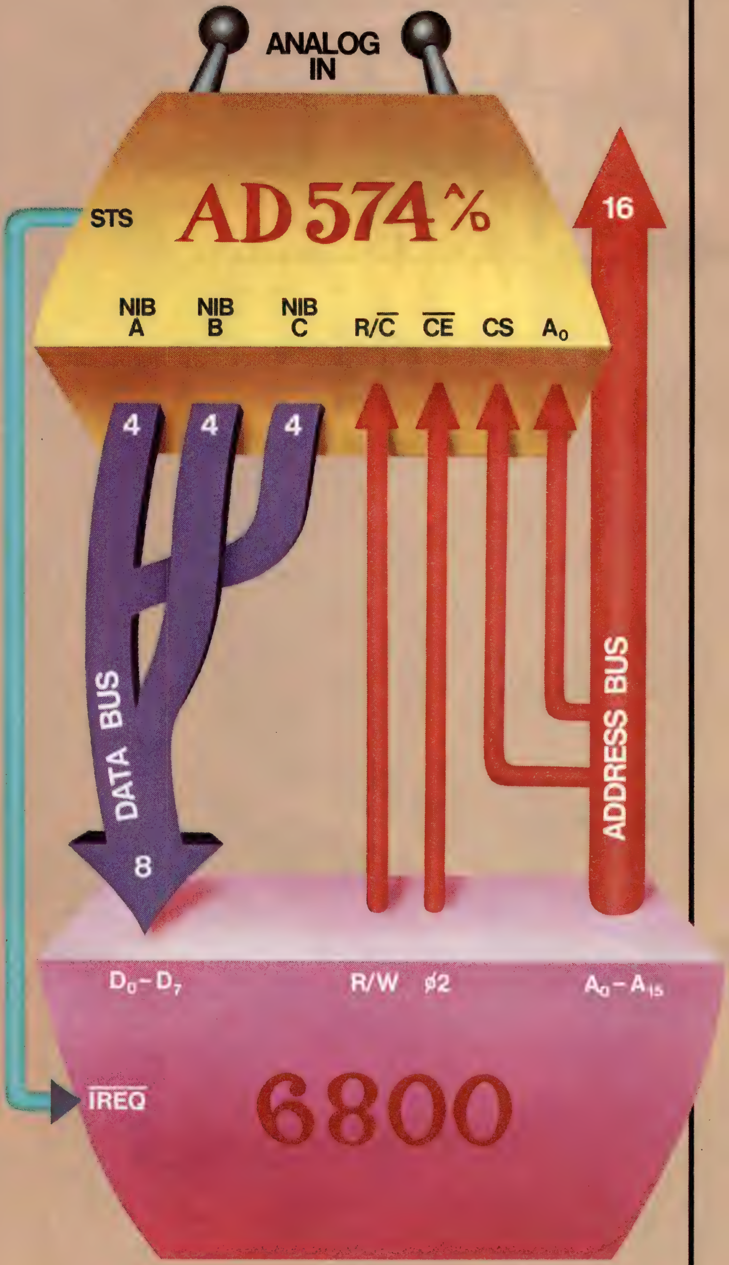
The new AD574 is the lowest cost, most integrated, easiest-to-use, fullest function fast 12-bit successive approximation analog-to-digital converter you can buy.

It makes ingenious use of linear compatible I²L to pack all analog and digital functions on just two chips in a standard, hermetically-sealed 28-pin DIP. The integration of all the stages, between sensor and processor, in a single IC package means you don't have to deal with error budgets of the many individual circuit components to achieve a circuit with 0.01% linearity (over temp.) and 25 μs conversion time.

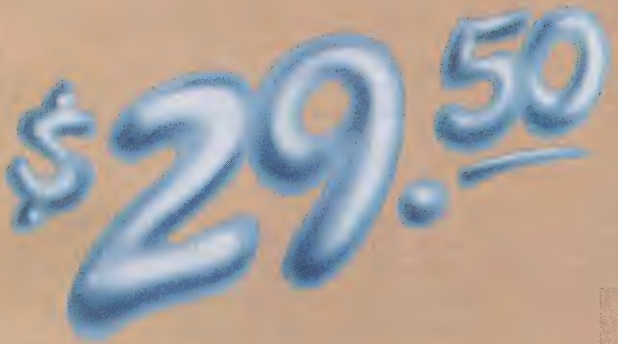
What's more you don't need any external trimmers to achieve full scale calibration accuracy of 0.05%. All you do is connect the analog input and start performing conversions.

COMPLETE INTERFACE FROM SENSOR TO PROCESSOR.

- **I²L successive approximation register**
- **High speed 12-bit DAC**
- **Internal buried zener reference**
- **Internal clock**
- **Full bus interface**
- **Precision comparator**



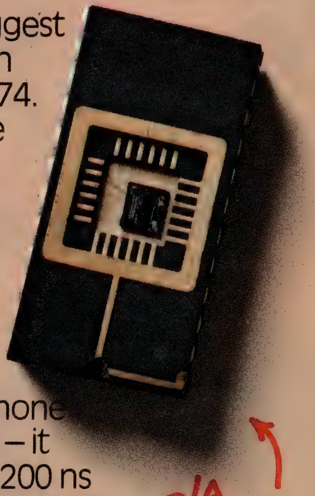
RACE IS OVER.

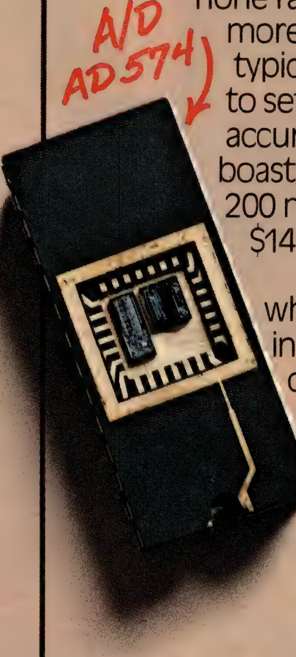


ANALOG TO µP THE DIRECT CONNECTION.

The AD574 is a cinch to interface directly to most popular microprocessors with an 8-bit bus like the Motorola 6800, Intel 8080 or Mostek 3870 (F-8), or a 16-bit bus like the Intel 8086, T.I. 9900 or Motorola 68000, without any external buffers or peripheral interface controllers. Multi-mode 3-state output buffers connect directly to the data bus while the read and convert commands are taken from the control bus. Which means the AD574 doesn't tie the CPU up with conversion routines and that the AD574 can also do very well on its own as a stand-alone converter. What could be simpler? And still only cost $29.50 in 1000s. Available now from stock.

HALF THE STORY IS THE WORLD'S FIRST SINGLE-CHIP 12-BIT DAC WITH ON-CHIP REFERENCE.





The AD565 chip is the biggest single reason for the high performance of the AD574. By itself, the AD565 is the world's first monolithic 12-bit digital-to-analog converter to offer on-board low T.C. voltage reference. This makes it the best 12-bit IC DAC you can buy. There are none faster and none more accurate – it typically takes 200 ns to settle to within 0.01% accuracy. The AD565 boasts low power (just 200 mW) and low price (just $14 in 1000s).

Which proves once again why Analog Devices is way out in front in converter technology. For more information and application details, call Doug Grant or Don Travers at (617) 935-5565. Or write Analog Devices, Inc., P.O. Box 280, Norwood, MA 02062.

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CIRCLE NO. 15

Two magnetic printers approach the speed of more costly nonimpact page printers with rates of 8000 lines/min. and 6000 lines/min.

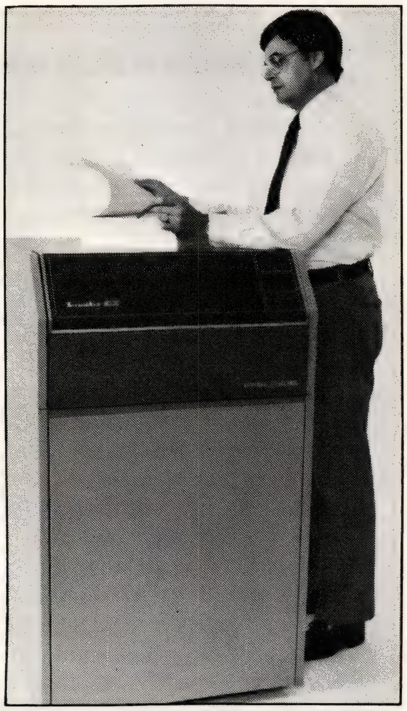
Magnetic printer produces 8000 lines/min.

At an eventual cost savings of 75%, nonimpact magnetic printers are approaching the printing speeds of other nonimpact page printers (electrostatic, laser and ink-jet). The TermiNet 8000 page printer from General Electric Data Communication Product Division (Waynesboro, VA) spews out 8000 lines/min., or 27,000 characters/s, in densities of 10, 12 and 13.3 characters/in. A proposed printer from Cii Honeywell Bull (Belfort, France) prints 6000 lines, or 80 to 90 pages per minute. The printers get their impressive results from two different magnetic technologies: GE relies on magnetic-tape imaging media and Cii Honeywell Bull relies on a magnetic drum.

GE favors the Mylar magnetic tape, or belt, for imaging because the imaging heads are kept internal to the tape. When the chamber is pressurized, the write head is isolated from the ink toner. The toner cannot grind the print head (the toner can often act like a lapping compound and become abrasive). With a magnetic drum, the toner can contact and abrade the head. General Electric feels that the drum technology also has some unresolved alignment problems, like maintaining the distance of the head to the drum.

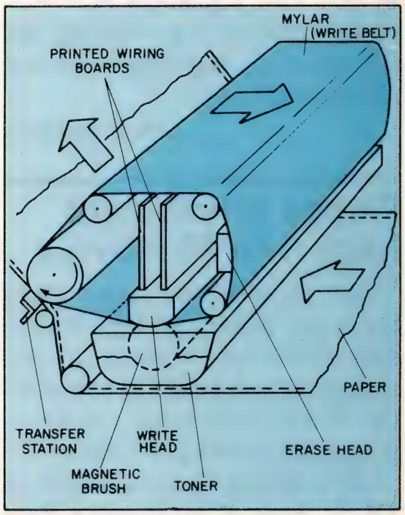
The special print head of the 8000 (ELECTRONIC DESIGN, July 19, 1979, p. 25) uses the soft surface of the Mylar tape for writing a magnetic dot pattern directly on the belt. Then the belt picks up toner. The toner and the paper meet with a slight pressure and an electrostatic action upon the paper. The toner sits on the paper loosely. After the paper passes through two rollers (a heat roller and a pressure roller), the print is fused on. The paper is fed through the printer at a constant rate of 16.7 in./s.

In the print head, two elongated PC boards are mounted directly over the imaging (write) head. These boards are driven by Z80-based logic circuits. The μP operates at 4 MHz to ensure that data transfer at 25,000 characters/s, to sustain the printing speed. The logic circuitry also contains a 16-kbyte buffer.



The magnetic printer can replace impact printers like the IBM 3211 and 1403, which are rated from 1000 and 2000 lines /min. but cost about the same as the 8000.

The 8000 currently offers a serial interface and will soon offer a parallel interface. At the transfer rate of 25,000 characters/s,



The TermiNet 8000 nonimpact magnetic printer (left) uses magnetic imaging and dry toner ink. Characters are imaged on a rotating write belt in a dot-matrix pattern. After the print fuses to the paper, the belt rotates past an erase head.

the printer interface is too fast for most communications networks; a 5:1 ratio is needed.

GE announced the printer officially at the National Computer Conference (Anaheim, CA) earlier this month and expects to begin volume production by 1981.

Cii Honeywell Bull described its alternative, metallic drum-based magnetic printers at the International Magnetics Conference (Boston, MA, April 21 through 24, 1980.)

Along the solid drum are 1728 parallel heads, assembled in nine 2-in. modules (192 heads/module). Resolution is 120, 180 and 240 dots/in. The drum measures 440 × 180 mm and contains a special external magnetic layer.

The head response is fast enough to accommodate control by a time-multiplexing scheme. The 48-bit control word that drives the head requires only 100 mA of drive current.

Honeywell expects to announce the printer for the OEM market in a few months. Prototypes have been tested at a printing cycle of 10-million pages and at 600,000 pages/month. Honeywell also reports a 90% efficiency rate in transferring the ink toner to the paper without abrasion problems.

Len Yencharis

Floppy drives fight back with 10 Mbytes

A 5 to 10-Mbyte range gives the latest guarantee that floppy-disk drives will survive the onslaught of advances in Winchester disks. Still more improvements are expected by 1981.

The 5-Mbyte floppy diskette at 3M (St. Paul, MN) offers an areal recording density of 1.4×10^6 bits/sq in. (2.1×10^5 bits/sq cm). The use of both sides would create a 10-Mbyte product, and double-density recording creates a 20-Mbyte floppy file.

According to A.E. Smith, vice-president and general manager of 3M's Data Recording Products Div., "Diskettes will be bigger than tape one day soon, measured on a dollar basis." With the mini and microcomputer markets growing by 30% per year, the future for the floppy will be enhanced.

The cost of a high-performance floppy can be kept down by accepting a certain number of errors and then either marking these parts of the surface or using more sophisticated error-correction techniques, claims Geoffrey Bate, vice-president of advanced technology for Verbatim Corp. (Sunnyvale, CA). More sophisticated error-correction techniques or codes for flexible media will emerge in the next few years as the cost of the circuitry to implement those codes is reduced. Improvements in uniformity, surface condition and magnetic properties will accompany smaller recording heads and low-cost controllers. Bate estimates that a 50-Mbyte floppy is possible by 1990.

Advanced technology is already part of the Burroughs Corp. (Detroit, MI) MD122 6-Mbyte floppy drive. A new air-bearing design (ELECTRONIC DESIGN, Oct. 25, 1979, p. 64) allows the recording heads to fly over the disk surface at 8 μin., one-third to one-half the flying height for most Winchester drives. The track density is 150 tracks/in., a jump of 50% compared to other high-performance floppy drives.

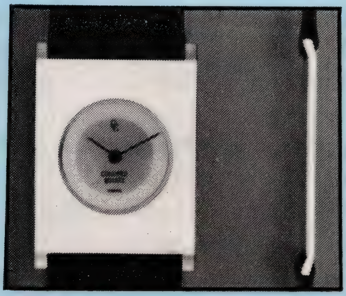
The oxide coating on the media is reduced to 50 μin. (a reduction of 50%) and the media is preinitialized. The preinitialized media is still uncommon in 8-in. Winchester drives.

To resolve noise-margin problems in double-density recording, MFE Corp. (Salem, NH) has developed a double-density data-recovery circuit. Remex (Irvine, CA) offers another solution to the density problem: an intelligent controller (ELECTRONIC DESIGN, Oct. 11, 1979, p. 62) The approach seems likely to appeal to other designers using floppy drives.

Len Yencharis

μP-based watch is world's thinnest

At 0.98 mm—35 mils—the $10,000 Delirium IV from the Concord Watch Co. (New York, NY) is the world's thinnest wristwatch.



The watch (shown in actual size) employs a 32,768-Hz quartz element with a 1.45-mm tuning fork. Accuracy is within 10 seconds per month. First, a CMOS μP produces three 8-ms impulses per minute. The stepping motor (also claimed as the world's smallest at 14 × 5 × 0.70 mm) then moves the minute-hand disk three times per minute. The hour and minute hands are on thin rotating disks. The battery (again, the world's smallest) is a silver-oxide 1.55-V cell measuring 0.80 × 6.8 mm that will operate for one year over temperatures ranging from −5 to 60 C.

The 18-karat gold back of the watch is "scooped out" on the inside to serve as a plate for the watch's movement.

E-beams, fast bipolars, denser PROMs coming TI's way

VLSI circuits are in sight, and electron-beam fabrication will play a big part. So says Texas Instruments (Dallas), which sees line widths shrinking to 1 μm and new materials for gate oxides being developed to help with the shrinking. In the short term, meanwhile, improvements in processing technology will consolidate functions within existing 9900 16-bit microprocessors and advance such bipolar circuits as PROMs and discrete devices.

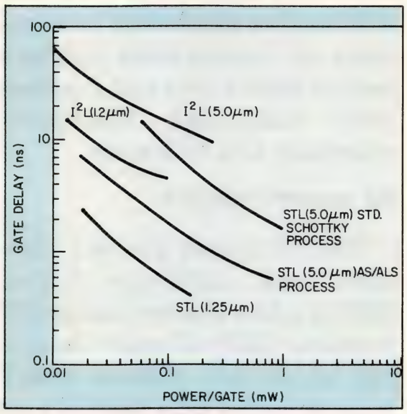
Since the scaling-down of MOS memories has almost reached its practical processing limits, new materials will have to play a significant role in the planning of a 256-kbit RAM, according to TI. Currently, the TI TMS4164 64-k RAM uses a scaled process that includes 0.5-μm junction depths 2 to 3-μm isolation and 400 to 500-Å gate oxides. The 500-Å thick gate oxides represent the state of art in semiconductor processing.

The need to fabricate thinner oxides—in the 200-Å region—will require research into such higher dielectric materials as titanium oxides and tantalum oxides. What's more, the present 2 to 3-μm isolation between diffused bit lines will limit how much the main-memory cell device can be scaled down.

Static and nonvolatile memories will also increase in capacity to resolve many users' memory hierarchical problems. A 128-kbit EPROM, predicted for 1983, will probably use floating-gate and scaling techniques. Static RAMs will be helped to the 64-kbit level by double-polysilicon resistive loads, which replace active saturated cells.

However, for the density increases needed to bring VLSI to reality, TI will lean heavily on electron-beam technology. Besides promising to increase circuit density—especially RAMs—E-beam will improve both yield and circuit performance.

Experience with the superior registration capability of E-beam techniques over that of conventional optical systems shows about a fourfold increase in good chips per wafer—a yield increase from about 12.5 to 50%. In addition, the fine-line resolution of E-beam—which promises to shrink from a present limit of about 2 μm optically to about 1 μm—will allow manufacturers to place twice as many circuits on the same wafer. That means a total output of eight times as many good circuit chips per wafer slice could be coming.



Speed-power performance of bipolar logic shows significant improvements can be attained with 1.2-μm I^{2}L and Schottky TTL.

Moreover, circuit performance goes up, too, mostly because of closer "component" spacing, and thus shorter "wiring," which reduces signal delays and allows circuits to operate at higher speeds.

For example, I^{2}L bipolar logic gates built with conventional 5-μm geometry have gate delays of about 15 ns. E-beam methods reduce the delay to about 5 ns, when equivalent gates are built with 1.25-μm geometry (both operating at 0.1-mW/gate).

Schottky and TTL circuits will also benefit from E-beam. When built with 5-μm geometry by standard processes, STL gates have delays of about 8 ns; with E-beam 1.25-μm geometry, the delay drops to about 0.5 ns.

Meanwhile, an assortment of new bipolar PROMs in three families—standard, low power and "power down"—are slated for introduction over the second half of 1980. The largest of the standard devices, the 28S166, is a 16-k (2048 × 8) chip with 35-ns access time and power dissipation of 500 mW. By contrast, the low-power 28L166, also 16-k, consumes just 275 mW and sports an access time of 65 ns. The "power down" series, designed for critical speed-power product uses, features a chip enable power-up which holds power consumption at 80 mW before enabling, and 500 mW thereafter. A 4-k chip, the 28P42, will be sampled in August, while a 32-k device will appear late next year.

TI also plans an abundant assortment of discrete semiconductor devices in 1980, ranging from optical assemblies to sensor products—temperature, liquid-level and flow.

The series of fiber optic pigtail assemblies, housing either sources (TXES family) or detectors (TXED) are packaged in six-pin plastic dual-in-lines. The PC-board mountable units have 5 different pigtail lengths (5 to 100 cm), and the sources operate at either 790 or 850 nm. Detectors feature an integral reference diode and 8 ns rise time at 5-V.

TI's temperature sensors use positive-temperature-coefficient thermistors. Two new devices, the TSF102 and TSU102, come in Mini-Therm packages and sell for $0.27 in quantities of 50,000. The liquid-level sensor LLSM-2 takes advantage of heat-transfer characteristics to determine the presence or absence of liquids.

32-bit supermini puts 3 processors to work

A compact, 32-bit "super" minicomputer strengthens its performance while minimizing data movement and system overhead by incorporating three separate processors—one for the CPU, one for the input/output system and one for overall system control. In addition, the Eclipse MV/8000, from Data General uses programmed array logic (PAL) and VLSI circuits to produce the central processing unit on five 15-in. PC boards, making it 75% smaller than current superminis.

A virtual storage machine, the MV/8000 features hardware and system software both compatible with all of the Westboro, MA company's 16-bit Eclipse systems. In addition, the MV/8000 has 4.3-billion bytes of natural address space and user address spaces as large as 512 Mbytes apiece. Memory-system throughput runs at 36.4 Mbytes/s, with I/O-to-memory and CPU-to-memory transfers to 18.2 Mbytes/s.

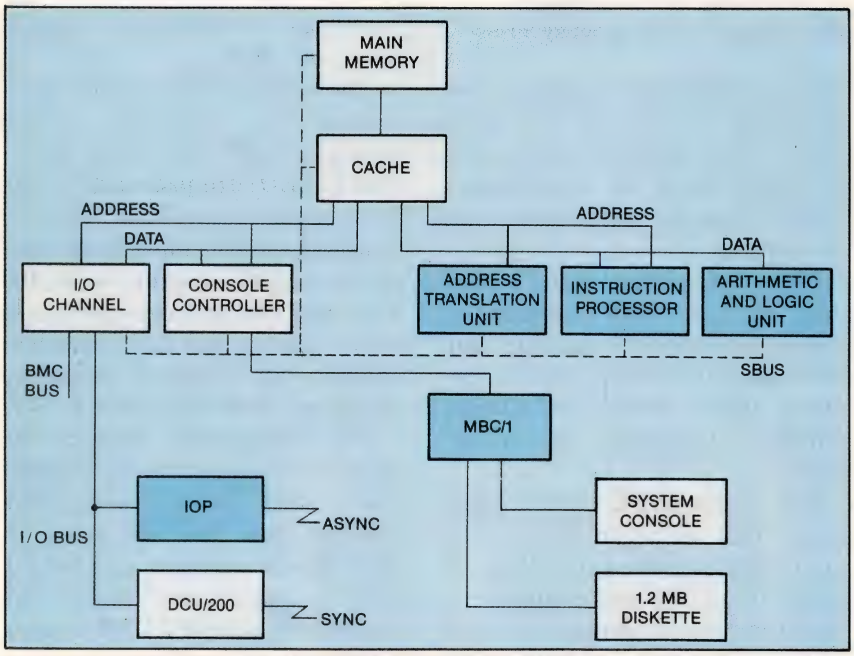
The CPU, system-control and I/O processors make up three of the MV/8000's four major subsystems—memory is the fourth (see Fig.)

The CPU features a four-stage implementation that allows instructions to be fetched, decoded and executed simultaneously. The CPU also includes a 1-kbyte instruction cache, which uses a look-ahead, look-back technique to increase speed. A RAM-based microsequencer holds the control store for microcode.

For complex operations, the CPU puts a high-speed, 32-bit arithmetic logic unit to work. One ALU section operates on the exponents in floating-point numbers and the other works with floating-point mantissas, fixed-point quantities and addresses.

I/O system—packed

The I/O system places a high-speed burst multiplexer channel (BMC), a data channel and an I/O processor (IOP) all under the control of the I/O channel board. Input or output data need not pass through or interfere with the processor. Data are transferred via the BMC, the data channel or the IOP, and move directly to and from the system cache.



The Eclipse MV/8000 32-bit supermini augments its main CPU with an I/O processor and an MBC/1 single-board processor for diagnostics. Cache memory is dual-ported, allowing access by CPU and I/O circuits.

The BMC, a high-speed direct-communications path between main memory and high-performance peripherals, transfers blocks of data at up to 16.16 Mbytes/s. The data channel, operating at rates up to 2.27 Mbytes/s, handles communications between the CPU and medium-speed peripheral equipment like magnetic-tape drives.

The IOP, an independent processor with an Eclipse instruction set and 64 kbytes of local memory, processes and buffers data input from such low-speed peripherals as display and printer terminals, card readers and digital plotters. It also acts as a front-end processor for overall system, off-loading the CPU by buffering all low-speed input, checking it for errors and sending it to main memory via the system cache.

The System-control processor (SCP) acts as an independent diagnostic processor. Controlled by a Data General microNova-type MBC/1 board computer, the SCP works with a separate diagnostic scan bus for direct access to system boards.

A diskette drive stores the SCP's operating system, the MV/8000 microcode, and special diagnostic microcode; it also serves as a log for system abnormalities detected by the SCP.

For system software, the MV/8000 uses Data General's new multiprogramming virtual operating system, the Advanced Operating System/Virtual Storage (AOS/VS), which schedules processes and I/O resources to maximize system throughput. In addition, AOS/VS supports Data General's three new 32-bit high level languages, which conform to ANSI standards: AOS/VS Fortran 77, AOS/VS PL/I, and AOS/VS Basic.

More decisionmaking for memory-chip ATE

At current levels of computer sophistication, accurate digital testing entails data management and actually changes into an analog problem, according to Jack G. Salvador, president of Macrodata (Woodland Hills, CA). High-volume testing creates data that must be collected, often from widely dispersed facilities, and reduced on-line and in real time. Decisions on memories that were formerly rendered by a go/no-go test, now require sensitivity to the degree and character of the problem, so that the bad memories can be reclaimed as partials. The advances in memories are exerting pressure for a comparable sophistication in testers.

"The tester must handle the complete testing job and accumulate a complete set of data," states Salvador. To reduce data from each test station in real time and on-line, users then rely on host computers. "The need for a host system has been discussed in the industy for about five years," Salvador points out. "My definition of a host requires that a clear line be drawn, distinguishing testing from data management and data manipulation. For the most part, the ATE industry today offers testing, not data management, with host computers. Data reduction, shmoo plotting, data logging, and so forth, address testing. If the computer is added merely to handle test data, it cannot serve as a host because its primary job is to make the tester a complete system."

Macrodata's latest tester supplies stand-alone computing power, multiple timing sets, edge accuracy, internalized automatic calibration to solve some analog problems and hybridized pin electronics that more closely approximate device pins. According to Salvador, it constitutes the fourth generation in the history of testing devices.

To put test system architectures into focus, Salvador recounts their history, providing definitions of generations of the equipment that admittedly are debatable and often confused even within the ATE industry.

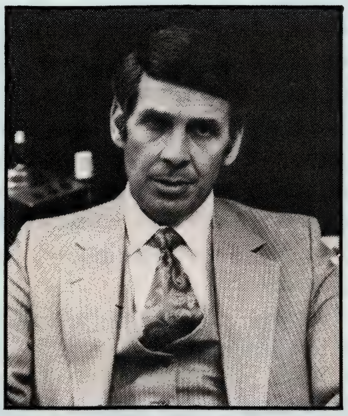
The first generation of test machines was a benchtopper, termed an exerciser, used basically as a logic generator. It did not provide pin electronics, timing or any basic intelligence. Dynamic RAMs, which presented special real-time testing problems, motivated the second generation of memory testers.

Because of the refresh requirements, a dynamic RAM memory required a subsystem merely to prove that it would store a ONE or a ZERO. If refresh criteria were violated, the part would simply die. So dynamic RAMs led to testers in which the pattern generator (exerciser) was surrounded with timing, pin electronics and some limited intelligence. This machine was usually hardwired.

As semiconductor memories became more complex and faster, memory testers became fully computer operated and computer controlled. The machine memory and the software intelligence were integral to the testing. These third-generation machines involved sophisticated engineering considerations, such as characterization, shmoo plotting and other diagnostic tools.

The problems that must be handled by fourth-generation testers are quite different from those faced by the earlier machines. "Now, after taking continuous test data, the user wants to look at things like summary lot information. This implies data management and data manipulation," explains Salvador, "very much like a large inventory system by lots. The information relates not only to testing, but to controlling overall capital, and that, I believe, represents the proper use of a host computer."

Another of the new problems is testing for partially good memories. Memories that would have gone into the reject bin can be reclaimed as partials through several methods, but at a tremendous cost in throughput on the



Jack G. Salvador has been associated with automatic testing for more than 15 years, and has held various executive and management positions in electronics for more than 20 years. He received his B.S. and M.S. in electrical engineering from the University of California at Berkeley.

Having started his professional career with the Lawrence Radiation Laboratories and Varian Associates, Salvador concentrated on working with dc parametrics for semiconductor testers. In 1968, he founded Triangle Systems, a joint venture between EH Research and Teradyne Corp. The company produced the first semiconductor tester combining dc parametrics with fast-pulse ac measurement.

Subsequently, Salvador directed the design and development of Teradyne's logic and memory testers. In 1976, he joined the Macrodata semiconductor test systems division of Eaton Corporation as executive vice president, rising to president in 1978.

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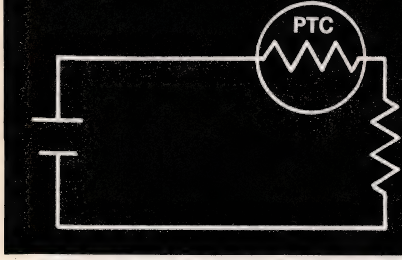

In normal operation the PTC experiences an insignificant amount of self-heating. However, when a fault voltage of significant magnitude does occur, the PTC heats, which results in a reduction in current through the circuit.

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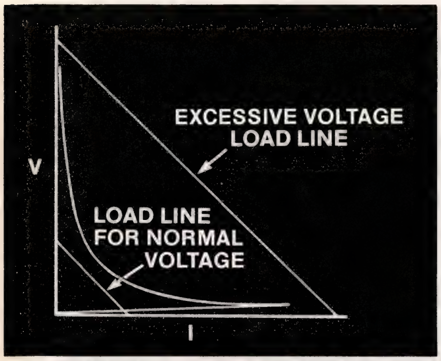

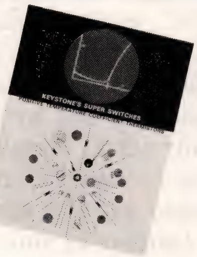

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test line. This issue, wrapped up in real-time error processing, again raises the stakes in testing. Instead of a basic go/no-go decision, the tester must determine how much and what part of a memory is good.

"To handle the partials testing problem, we must build more intelligence into the error processing portion of the machine," says Salvador.

In one typical approach, a capture RAM stores all the errors that occur throughout a complete device test. Then a computer, which is running at a much slower speed, analyzes the stored error data and decides whether the part will be acceptable as a partial device.

"Teradyne uses this approach and claims partial decisions can be made in 80 ms. With the old wafer probe, the real-time decision point is typically reached in about 20 ms. The capture RAM adds another 80 ms to the decision, and that becomes a throughput issue. That's why a real-time error processing method should be developed."

Good from bad

The critical point in the tester's performance is its ability to separate the good from the bad devices when the device is only a count away from the specification limit. "People tend to think of memory testing as a digital issue, and yet, at the moment of the specification, all of the waveforms on the device are in their transition regions," explains Salvador. "This measurement is really an analog measurement."

Therefore, changes in basic tester architectures are needed to address the accuracy of analog parameters. "For example, you can have a digital time base that has very good accuracy, but if the rise and fall times of the driver waveforms wander around a great deal, then the device could be inaccurate by factors of two or three."

Salvador says that the sophistication of test system users has also increased; they realize what causes errors and correlation problems in devices, and they are very aware of the need for better analog performance. Machine performance has to be specified at the device pins. "Any other specification is an intellectual exercise that does not tell what kind of performance can be achieved in part testing." Salvador backs up his viewpoint with an explanation of the difficulty in verifying measurements at today's speeds.

Accuracy or correlation?

"Everybody would like to have subnanosecond accuracy in a tester, but a fundamental problem is that the laboratory instrumentation currently available does not guarantee some of the specifications that are being quoted. Even the best time-interval counters are guaranteed to accuracies of just 600 ps, yet people are using them to decide whether or not a machine is accurate to within 200 ps. The result is not really an absolute accuracy measurement, but a correlation measurement."

The user sets up a few acceptable devices as the reference standard. Most of the large producers have a few hundred devices they have sorted into various bins. They run these through the testers to verify that, say, 95% or better of the parts are binning correctly. If the machine can properly and repeatedly separate the good ones from the bad ones, its performance is considered adequate, and the correlation is established.

In two years, Salvador predicts, all successful memory component test systems will feature new architectures that address all of these problems.

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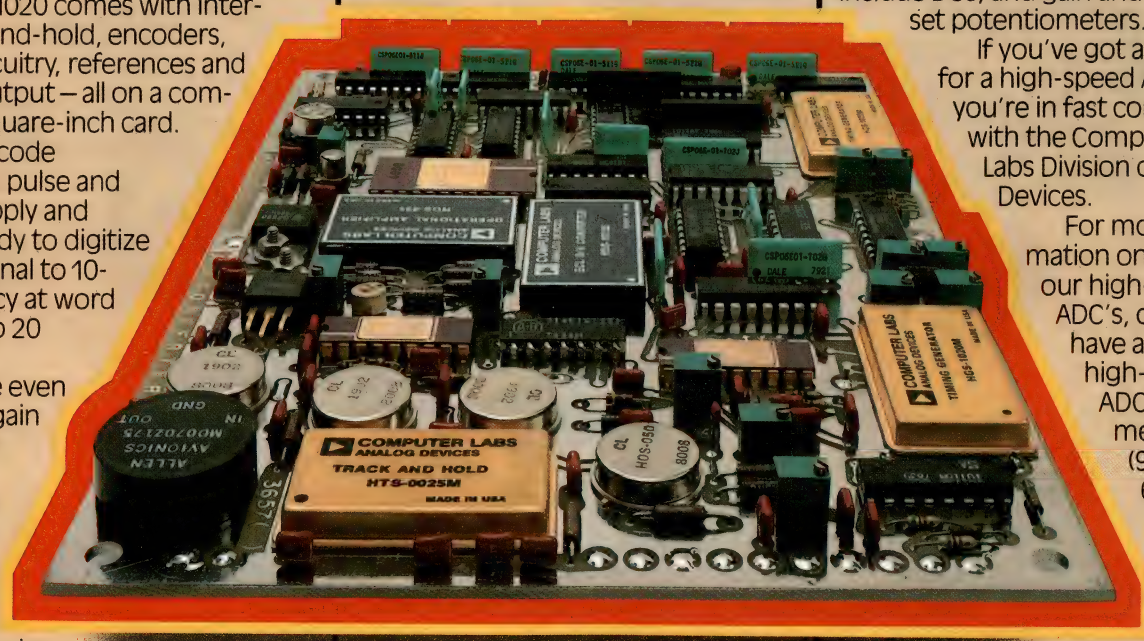

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CIRCLE NO. 151

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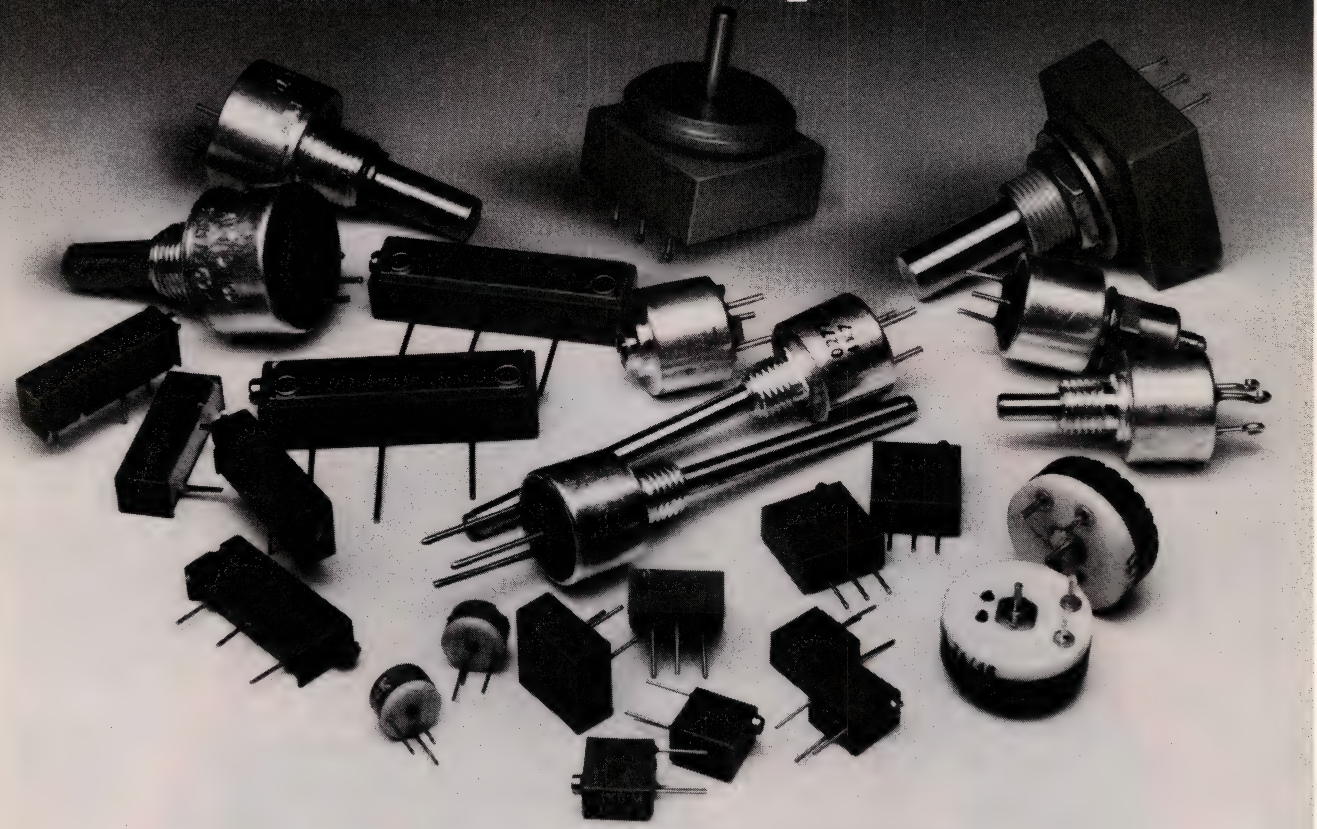

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CIRCLE NO. 152

0658 2 0068

ElectronicDesign

INTERNATIONAL

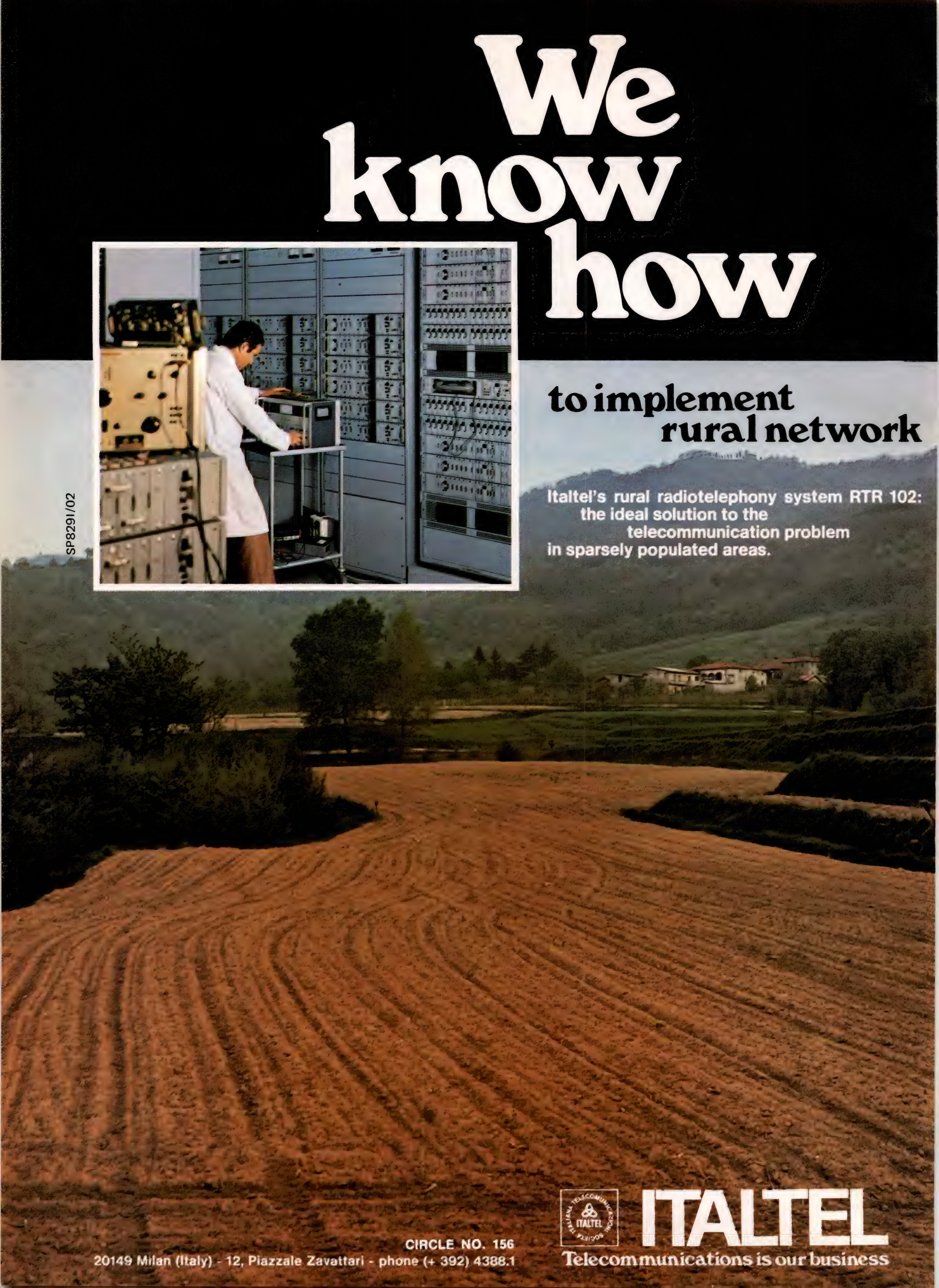
May 24, 1980

Data tablet reads handwriting

Unit monitors conductivity of solutions

DPM signals range limits with change of color

Analog multimeter features linear resistance scales



Italtel's rural radiotelephony system RTR 102:
the ideal solution to the
telecommunication problem
in sparsely populated areas.

SP8291/02

CIRCLE NO. 156
20149 Milan (Italy) - 12, Piazzale Zavattari - phone (+ 392) 4388.1

ITALTEL
Telecommunications is our business

Data tablet reads handwriting

A solution to the problem of easy man-to-machine communications comes in the form of a data entry tablet. Handwritten information is recognized, digitized and sent for storage in on or off-line computers, by the tablet from Image Data.

Unlike some other digitizers, the Image Data tablet recognizes handprinted block capital letters through a program in an associated microprocessor. The software recognizes a wide range of handprinting styles. A bleep sound indicates a poorly made character. If characters are not accepted, a touch table serves for alternative data entry.

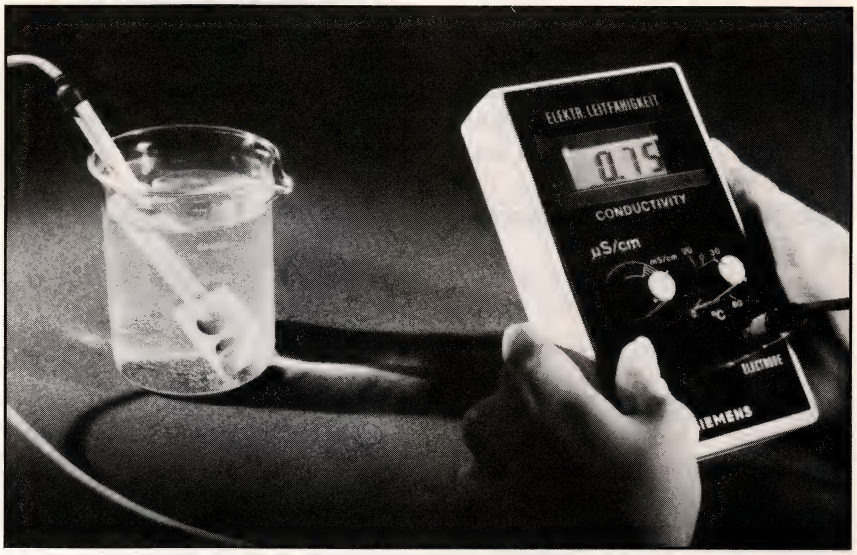
The tablet acts as a digitizer for designs or drawings when used in conjunction with a special pen. Results are displayed and stored and can be brought out of storage for modification. As a bonus, an integral calculator solves mathematical problems from handwritten information.

Ten keys on the touch table are allocated for the specific requirements of a user.

Image Data Products, 1-4 Portland Sq., Bristol, BS2 8RR, England. (0272) 40248/9. Telex: 449752 Chacom G.

CIRCLE NO. 501

Unit monitors conductivity of solutions



The electrolytic conductivity of aqueous solutions, important in electro-plating baths and in the sampling of process solutions, can be monitored with a portable tester, the M 54245. The battery-powered instrument measures over the range from 1 μS/cm to 20 mS/cm—the difference between fully demineralized water and sewage water.

In operation, the M 54245 applies an ac voltage to two electrodes immersed in a solution, causing a current flow which can be temperature-compensated and amplified.

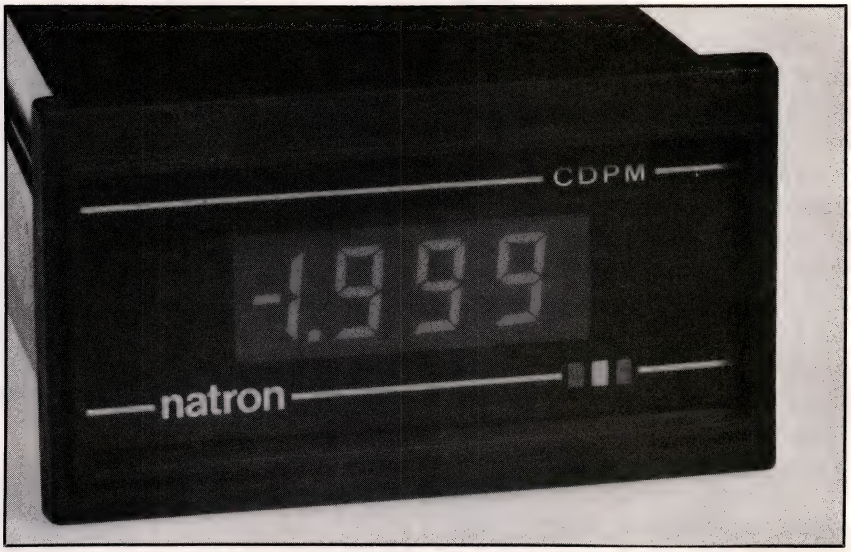
The temperature of the solution under test can range from 0 to 50 C. The measuring unit can be switched to any of four ranges. Measured values are displayed on a 13-mm high LCD.

A voltage comparator circuit reduces the 9-V battery voltage to a 5-V reference voltage. An indicator, on the display, warns of a low-voltage condition.

Siemens AG, Postfach 103, D-8000 Munich 1, Federal Republic of Germany. (089) 23 41. Telex: 05 23 121.

CIRCLE NO. 502

DPM signals range limits with change of color



Critical upper and lower limits are spotted easily on a multicolor digital panel meter from Natron Electronics, the CDPM. The color of the display's digits changes as input levels pass through user-set levels.

Input levels are adjusted by trimmer potentiometers. A front bezel snaps off to reveal the conveniently accessible controls.

Standard colors are green, yellow and red. The seven-segment field-effect LCD shows 3½ digits measuring 0.5-in. high. The sequence of displayed colors can be arranged to suit the user.

The digital meter, which is built around a dual-slope converter, has a reading rate of 3 per second. Response time is 10 ms to within 0.1% for a full-scale step input. The meter boasts an input impedance of greater than 100 MΩ, and it has input ranges of 200 mV full scale and 2 V full scale. Common-mode noise rejection is greater than 80 dB.

Natron Electronics Industries, Moshav Zur Natan, D. N. Hasharon Hatichon, Israel. (052) 29485. Telex: 35770.

CIRCLE NO. 503

Analog multimeter features linear resistance scales

An analog multimeter, Philips' PM2505, does more than supply a constant 10-MΩ input impedance: It provides linear scales for all of its functions—even resistance. The result is a resistance-measurement error of 3% of full scale —a far cry from the 7 to 10% offered by conventional reversed-log scales.

The scales cover 100 Ω to 30 MΩ, 100 mV to 1000 V dc, 100 mV to 600 V ac, and 1 μA to 10 A ac and dc. In addition, an ac signal scale is calibrated in dB. A diode-test range and a battery check complete the testing options. In addition, a so-called Resistone continuity check provides a sound signal when the test leads are interconnected by less than 20 Ω.

A taut-band, central-magnet, moving-coil movement is used for display, with the central magnet assuring high accuracy and repeatability. Dc voltage and current measurements are accurate to within 1.5% of full scale. The movement is immune to external magnetic fields and produces no field radiation.

The PM2505 protects itself from accidental damage by resisting voltage overloads to 1000 V continuous, with even higher peaks. Resistance ranges tolerate up to 265 V, while the current function remains undamaged by as much as 16 A.

The multimeter complies with all international safety and performance standards, including IEC, DIN, UL and CSA. Accessories include a 31.6-A current shunt, a 100-A current clip-on transformer and a high-voltage probe with a maximum rating of 30 kV dc.

N.V. Philips' Gloeilampenfabrieken, Science and Industry Div., P.O. Box 523, 5600 AM Eindhoven, The Netherlands. 040-783562. Telex: 51573

CIRCLE NO. 504

Only TEAC makes both on-site and in-lab cassette data recording equipment.

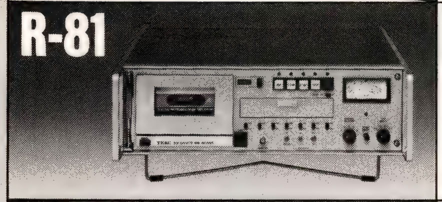
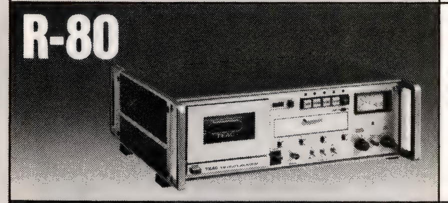
Have you been going to one manufacturer for your portable data recorders, and to another for recorders for your lab? TEAC makes things easier for you by offering a complete line of data acquisition equipment including both portable and lab models. Complete compatibility allows you to collect data in the field with a convenient portable recorder and bring it back to the lab for analysis on a full-feature lab recorder.

Of all our models, you'll find that our cassette-format recorders are the most convenient. The R-60, R-61 and R-61D portable cassette data recorders have proven extremely popular because of their ruggedness, stability of operation and light weight. They can record four channels of data in a choice of DR or FM format.

Back in the lab, the R-80 and R-81 provide big-recorder performance and features without using up a big amount of space or budget. Both can be mounted in standard E.I.A rack panels if desired.

These five cassette data recorders are part of a complete line of data acquisition equipment. Only TEAC can handle *all* your data acquisition needs.

Feature Comparison Chart

Model / Feature	Channels	Record System*	Tape Speed	Freq. Response	Power	Weight
R-81 	7	FM (DR: option)	4 speeds (7½, 3¾, 1⅞, 15/16ips)	FM: DC — 5k Hz at 7½ips	DC Car Battery (AC with AD-80)	12kg approx.
R-80 	4	FM (DR: option)	4 speeds (7½, 3¾, 1⅞, 15/16ips)	FM: DC — 5k Hz at 7½ips	DC Car Battery (AC with AD-80)	12kg approx.
R-61	4	Ch-1: FM/DR Ch-2: FM/DR Ch-3: FM Ch-4: FM	1 speed (1⅞ips)	DR: 50 — 8k Hz FM: DC — 625 Hz	DC Car Battery with CL-61 (AC with PA-2)	4.7kg approx.
R-61D	4	Ch-1: DR/FM Ch-2: DR/FM Ch-3: DR Ch-4: DR	1 speed (1⅞ips)	DR: 50 — 8k Hz FM: DC — 625 Hz	DC Car Battery with CL-61 (AC with PA-2)	4.7kg approx.
R-60	4	FM	1 speed (1⅞ips)	FM: DC — 625 Hz	AC	6.5kg approx.

* Noise Comp. & Memo capable

TEAC

TEAC CORPORATION: 3-7-3 Naka-cho, Musashino, Tokyo, Japan Tel: (0422) 53-1111

- U.S.A. B.J. Wolfe Enterprise Inc., Tel: (213) 877-5518
- Canada R.H. Nichols Co., Ltd., Tel: (416) 661-3190
- Hongkong Dah Chong Hong Ltd., Tel: 5-261111, 5-226258
- Australia & New Zealand Jacoby Mitchell Ltd., Tel: 6307400
- South Africa Mayfair Sales (Pty) Ltd., Tel: 011-834-2131
- Belgium & Luxemburg Simac Electronics S.P.R.L.,
- Denmark Danbit, Tel: (03) 141515
- France Tekelec Airtronic S.A., Tel: (027) 7536
- Holland Simac Electronics B.V., Tel: 040-533725
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- Switzerland Wenger Datentechnik, Tel: 061-34 50 96
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- Sweden teleinstrument ab, Tel: 08-380 370
- United Kingdom International Recorders Ltd., Tel: 04427 5959
- West Germany & Austria nbn Elektronik Starnberg, Tel: (08151) 13036

CIRCLE NO. 157

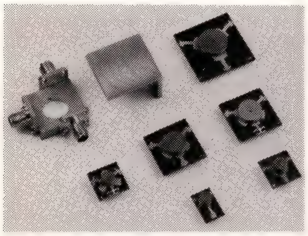
Integrated circuits
Semiconductors/Electron tubes
Components/Assemblies
Materials

NEWS FROM PHILIPS

MICROSTRIP CIRCULATORS AND ISOLATORS

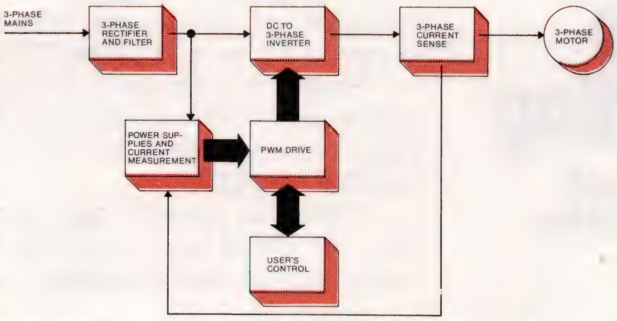
A new range of circulators and isolators covering the standard frequency bands between 2,2 and 11,50 GHz is now in production. The devices are manufactured in microstrip technology and comprise a small ferrite substrate on which a gold plated circuit and two Ticonal magnets are mounted. The size of the devices has been reduced as much as possible to minimize transmission losses. None of the devices has a substrate greater than 1"x 1".

A rectangular substrate has been employed throughout. This makes it easier to design-in the devices between two adjacent non-ferrite circuits. Connections between the circulators and isolators to the remainder of the circuit are made using the gold bonding technique. The isolators will withstand a maximum reflected power of 100 mW, and the circulators are designed for a forward c.w. power up to 5W. Measured in a specified test jig, the devices have the following typical performance: isolation $>$ 20 dB, insertion loss $<$ 0,4 to 0,5 dB and VSWR $<$ 1,3.



The new microstrip circulators and isolators are unconditionally guaranteed to meet our performance specification during their entire life.

CIRCLE NO. 800



NEW MOTOR CONTROL SYSTEM SAVES ENERGY

Important energy savings are possible with a new a.c. motor control system which we have developed. Based on the use of synthesised a.c., the new system employs double-edge pulse-width modulation of the rectified mains to produce the 3-phase voltages required by induction motors, and makes it possible for the first time to achieve economic variable speed control of a.c. motors in the range of 1 kW to 15 kW with components currently available.

Our new system allows the operation of conventional fixed-speed induction motors at variable speeds, thus overcoming one of the most formidable obstacles faced by designers of variable speed drives. In many applications, the use of this system can reduce the amount of energy required to power electric motors by as much as 40%.

Amongst the numerous advantages in addition to energy saving, are the use of low-cost, readily available, robust and maintenance-free motors; smooth start and an acceptable speed range of 10:1 above and below motor design speed; minimum power loss; no mechanical wear; minimum torque derating and low cost.

Existing fixed-speed drives can be made into variable-speed drives by the addition of an external 'black box' at low cost. Mains interference is significantly lower than present a.c. and d.c. motor control systems. The power factor of the new system is near unity, which gives greatly increased cost-efficiency in power consumption.

When the new system is used, the induction motor is driven from the outputs of an inverter. The rectified mains input to the inverter is sinusoidally pulse-width modulated to synthesise the required motor currents.

We do not manufacture motor control systems and our interest is in supplying the components and the system design to customers. Our dedicated LOCMOS LSI chip HEF 4572V is the heart of the system; this IC contains all the circuitry needed for optimum pulse-width modulation of the inverter. Then our high voltage, high speed switching transistors and, for higher powers fast turn-off thyristors, cover the power requirements up to 50 kW.

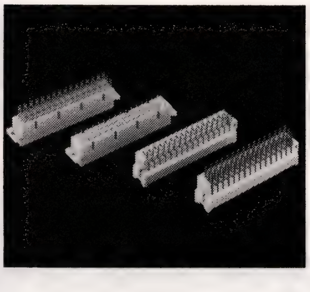
There is a formidable selection of rectifier diodes, including power rectifiers as well as commutation diodes. And passive components such as electrolytic smoothing capacitors, high power wire-wound resistors, trigger transformers, coil formers, ferrite toroids and transformer cores cover every requirement.

CIRCLE NO. 801

MORE IEC 130-17 CONNECTORS

Our range of F068-II heavy duty printed circuit connectors has been extended by the addition of two new types. To make more space available for interconnections on the PC board, we have introduced a new type of connector with straight dip-solder terminations measuring 0,6 x 0,6 mm compared to 1,0 x 1,0 mm for the previously released types.

A hand-solder version has also been introduced. This is provided with solder tag terminations which have been punched for easy attachment of the connecting leads. Male and female versions of the two new types are now available.



Our F068-II connectors are noted for their robustness - an extra steel spring reinforces the contact spring. With a high current carrying capacity and high working voltage, the connectors find ready application in power control systems, lifts, escalators and under severe environmental conditions such as those which arise in process industries and power stations. The high reliability of these connectors has also been demonstrated by their growing acceptance for use in private telephone exchanges. All F068-II connectors comply with IEC130-17.

CIRCLE NO. 802

15 A/800 V THYRISTOR WITH FAST TURN-OFF

Fast turn-off coupled with a 15 A/800 V rating are features of a new thyristor. Designated BT155, it is available in two versions with turn-off times of less than 9 µs (suffix N) and less than 12 µs (suffix P) These high speeds are achieved under the very adverse operating conditions of motor control and are only twice as long as their normal turn-off times. They can be further reduced by decreasing the gate bias voltage.

To achieve this performance, a special constructional technique is used in which high speed is the design target. The result is a fast device with asymmetrical voltage-current characteristics and a limited reverse blocking capability. Blocking is not required because the BT155 is normally driving inductive loads and operates with a diode in anti-parallel. The BT155 is supplied in the well-known reliable TO-220 encapsulation in which the chip surface is glass passivated and eutectically bonded to the lead frame. Pure silicone plastic is used for the encapsulation.

CIRCLE NO. 803

Philips Industries
Electronic Components and
Materials Division
Eindhoven - The Netherlands

PHILIPS
Electronic
Components
and Materials

PHILIPS

Pocket meter checks noise exposure

A pocket-size dose meter, Type 4431, monitors noise exposure levels. The compact unit is small enough to be worn without hampering work. A condensor microphone fastens directly to the meter or, with a preamplifier, attaches close to the wearer's ear. In addition to long and short term measurement modes for continuous readout, the instrument provides warning indications of exposure to short duration noise hazards in excess of 140 dBa peak. The meter is powered by an internal 9-V battery. A rechargeable NiCd battery and a charger are available as accessories. Conversion tables and a protective leather case are supplied.

Brüel & Kjaer, 18 Naerum Hovedgade, 2850 Naerum, Denmark. (45,2) 80 05 00. Telex: 37316 bruka dk.

CIRCLE NO. 505

Bubble memory stores up to 256 kbits

A non-volatile magnetic domain storage device, the NBM2256, stores up to 256 kbits. At an operating frequency of 100 kHz, the bubble memory has a data rate of 100 kbits/s and a 7-ms average access time to the first bit of a random data block. Typical power dissipation is about 750 mW. A bubble memory support chip family includes a controller, a function driver, a coil driver and a sense amplifier. The NBM2256 is housed in a 16-pin DIP with a 1.1 × 1.1-in. footprint, a 0.36-in. height and standard 0.1-in. pin spacing.

National Semiconductor, 301 Harpur Centre, Horne Lane, Bedford, England. (0234) 47147. Telex: 826209.

CIRCLE NO. 506

Compact relays suit high-density packing

A range of compact relays, the AZ 7 series, suits applications requiring high-density packaging. Silver-palladium, bifurcated contacts make the parts useful in telecommunications switching. The relays are available with two or four changeover contacts or two make-before-break contacts. Coil voltages range from 6 to 48 V dc.

Zettler Pressedienst, D-8000, Postfach 202626, Munich 2, West Germany. (089) 849056.

CIRCLE NO. 507

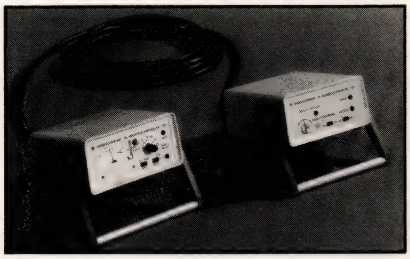
Light gate writes accurate waveforms

A programmable light gate array directs recording of input waveforms on the HR2000 Datagraph roll-chart recorder. The gate, originally developed to protect a pilot's eyes from the flash of a nuclear explosion, rotates the wavefront of polarized light passing through it in response to a change in its crystalline structure caused by an imposed electric field. Incoming analog signals are directed to voltage-to-time converters. Data is impressed on a ramp voltage which assigns the signal to a specific gate or sequence of gates. The result is a trace recording, with a high order of linearity, over a 12-in. record width. The inherent errors of magnetic-deflection systems are overcome. Paper speed can be varied from 0.01 to 126 in./s. Up to 28 channels can be recorded.

Bell & Howell, Lennox Rd., Basingstoke, Hampshire RG22 4AW, England. (0256) 20244. Telex: 858103.

CIRCLE NO. 508

Source/receiver pair measures attenuation

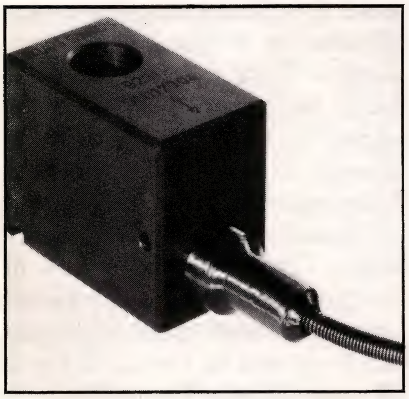


A level source and a standard level receiver combine to measure attenuation of wideband cables. The SKK level source produces two fixed-frequency signals at 47 and 294 MHz at a nominal output level of 98 dB each into 75-Ω loads. Selecting pre-emphasis cuts the level of the 47-MHz signal by 6 dB relative to the 294-MHz signal. The EKK level receiver, a superhet design, uses the two sinewave signals to determine the attenuation of wideband cables with an error of less than 1 dB. Level can be measured over a 50 to 110-dB range. Power for each unit is supplied by six type C cells.

Rohde & Schwarz GmbH, Muhldorfstr. 15, Postfach 80 14 69, D-8000, Munich 80, West Germany, Telex: 523 703.

CIRCLE NO. 509

Strain transducer uses piezoelectric disk



A strain transducer, Type 9231, uses a quartz disk to measure dynamic and quasistatic strains on machine components. The transducer mounts with a single screw. Strain on a base material alters the distance between two supporting surfaces of the transducer. This imposes a force on the quartz disk inside the transducer housing and creates an electrical charge proportional to the pressing force. Relative strain range is −300 to +300 microstrains (1 microstrain = 10^{-6} m/m).

Kistler Instrumente AG, CH-8408, Winterthur, Schweiz, Switzerland. (052) 25 28 21.

CIRCLE NO. 510

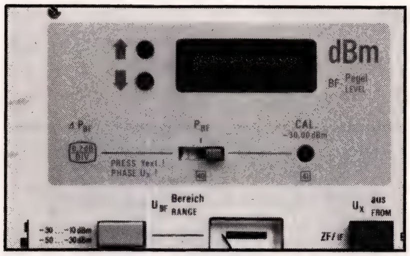
Video terminal displays French

A video terminal, the Model LGR-2F, features a complete ASCII upper and lower-case character set plus an upper and lower case French character set to CSA specification Z243.4 set 1 and set 2. Five of the keyboard key caps have dual legends with the ASCII character on the left and French characters on the right. Both sets have true descenders on lower case g, j, p, q and y. Switching between the two character sets is done by an external toggle switch. Standard features include an 80 × 24 alphanumeric character display on a 12-in. green-phosphor CRT, a detached keyboard with 15-key numeric pad and an RS-232C interface with 103-type handshaking.

Cybernex, 2457 Dunwin Dr., Mississauga, ONT L5L 1T1, Canada. (416) 828-2810.

CIRCLE NO. 511

Level meter enhances radio link test set



An internal, wideband level meter, an option for the RM-4 radio-link measuring set, enhances operation of the basic instrument for adjusting the sensitivity and linearity of modems in radio-link systems. The option's LCD readout offers 0.01-dB resolution. Typical error is held to less than 0.1 dB by an internal calibration source. Since the level meter is calibrated as quasi-rms, system loading can be measured. The unit works equally well with FDM voice signals or with band-limited noise, simulating the loading. End-to-end measurements are also possible.

Wandel & Goltermann, Postfach 45, Muhleweg 5, D-7412 Eningen, Federal Republic of Germany. (07121) 891-281. Telex: 07 29 833.

CIRCLE NO. 512

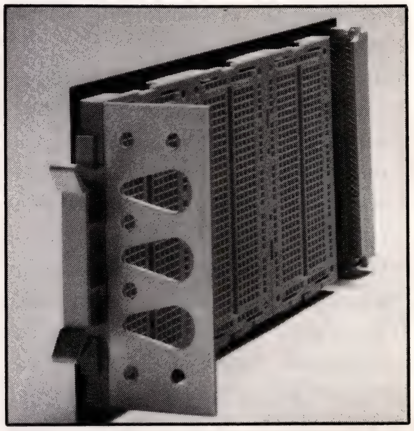
Video terminal serves LSI-11 μC system

A versatile video terminal, the VT103, operates as a building block in an LSI-11-based microcomputer system. The basic terminal comes with a CRT monitor, a detachable keyboard and an LSI-11 backplane with slots for up to eight plug-in boards. An optional dual, mini-cassette tape system fits into the terminal and below the screen. The VT103, built by DEC, has 132 column by 24 line display and 7 × 9 dot-matrix characters with true descenders and ascenders for easy reading. Special function keys serve editing and data communications. An internal power supply and a cooling fan are included.

Rapid Recall, 6 Soho Mills, Wooburn Industrial Park, Wooburn Green, Bucks, England. (062 85) 24961. Telex: 849439.

CIRCLE NO. 513

Proto boards mate for plug-in unit



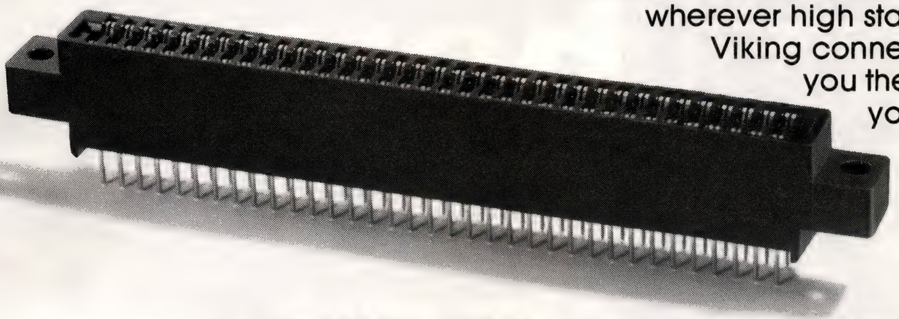
Three Veroblocs, a DIN connector, a front panel and a handle form a plug-in unit for circuit prototyping. The Veroblocs, dovetailed together, form a continuous 2.54 × 2.54-mm pitch, allowing use of any IC size. Bus strips for power use are provided on both X and Y axis on all three Veroblocs. All contact positions are clearly identified on an alphanumeric grid.

Vero Electronics, Industrial Estate, Chandler's Ford, Eastleigh, Hampshire SO5 3ZR, England. (042 15) 69911.

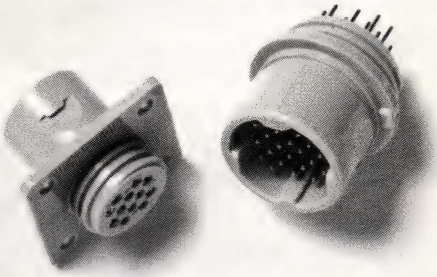
CIRCLE NO. 514

Connectors that meet the highest standards.

Wherever your equipment may be marketed, and wherever high standards are a requirement, use Viking connectors. They're designed to give you the high quality and reliability you need to meet your customers' standards.

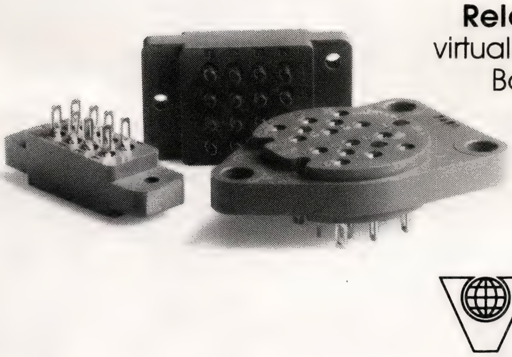


PCB Connectors One of the broadest lines on the market. Sizes range from connectors with 1.27mm (.050″) contact centers up through those with 3.96mm (.156″) contact centers. Choose from a variety of termination and mounting styles. Also, selective gold plating is available on many models.



Miniature Connectors Small, high-contact-density commercially priced circular connectors with a rugged, durable thermoplastic housing. They're used in all types of instrumentation from medical equipment and computers – to marine and automotive. Corrosion resistant. Quick disconnect designs. Simple, easy mounting styles. We can add standard cable, too – any length you need. Strain relief can be straight or right angle – and is fully molded, environmentally sealed.

Metal Circulars
Meet strict military and industrial standards with our Snap-Lock environmental connector. A complete line of miniatures with designs from 2 to 19 contacts.



Relay Sockets We have them for virtually every crystal can relay: Babcock, C.P. Clare, Deutsch, Electronic Specialty, Hi-G, LRE, Struthers-Dunn – and more. Top quality. Competitive prices.

Specials If you have a special problem, ask us for a special connector answer.

Viking
CONNECTORS

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1092 Buenos Aires
Phone: 37-9890-9476
Telex: 22153 RAYOX AR

Rodar Semiconductores, SACI
1017 Buenos Aires
Phone: 45-3422

Australia
Assembled Products, Pty., Ltd.
Liverpool, N.S.W. 2170
Phone: 607 0973
Telex: ASPROD AA23440

Austria
Dahms Elektronik GmbH
A-8020 Graz
Phone: (0316)64 0 30
Telex: 31099 DAHMS A

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Bodamer International BV
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Phone: 075/169740
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Phone: (416) 495-1412
TWX: 610-492-5113

Deskin Sales Corporation
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Taiwan Toko Electronics Co., Ltd.
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Phone: 299131-9
Telex: 81905 TWTOKO

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Lars Vallentin Electronik ApS
3660 Stenlose
Phone: 089-591053
Telex: 42547 VALLEK DK

France
E.R.N. Components
75017 Paris
Phone: 7-5-8840
Telex: ERNELEC 640051

International Semiconductor
92100 Boulogne Billancourt
Phone: 6045275
Telex: ISCAFRA 250030

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Phone: 0442233 TRAPPES

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Kowloon
Phone: 3-428131-6
Telex: HX73820 TOKOM

India
Sapphire Innovators Private, Ltd.
Nariman Point, Bombay
Phone: 234343
Telex: 115291 SIPL IN

Israel
Ira Curtis, ltd.
Tel Aviv
Phone: 45 71 48
Telex: 341458 IRAC IL

Italy
Auriema Italia, SRL
20149 Milano
Phone: (02) 430602
Telex: 332054 AURITA I

Japan
(Also Indonesia, Malayasia)
Toko, Inc.
Ohta-ku, Tokyo
Phone: TOKYO 7271161
Telex: RCLTOKO J22696

Korea, Republic of
Korea Toko Co., Ltd.
Jung-Gu, Seoul
Phone: SEOUL 22-5826

Mexico
Stocko Manufacturas Metalicas
Mexico 18, D.F.
Phone: (905) 277-5733
Telex: 1774265 MARMEX

New Zealand
Connector Systems, Ltd.
Auckland
Phone: 775-875
Telex: CONNECT NZ 21543

Singapore
Toko, Inc. Singapore Branch
Toa Payoh Estate
Phone: 554000 & 554621
Telex: SPTOKO RS21444

South Africa
Liberty Electronics
Boksburg 1460
Phone: 52 7637/8/9
Telex: 8-6732 SA

Spain
Ataio Ingenieros, SA
Madrid 16
Phone: 733 05 62
Telex: 44043 ATAIO E

Sweden
Gylling Teledata, AB
Farsta 5
Phone: 08-93 01 20
Telex: 17175 GETEAB S

LAC Components, AB
Stockholm
Phone: 08/94 91 70
Telex: 12842 LAC S

Switzerland
Egli, Fischer, & Co., Ltd.
8022 Zurich
Phone: 25-02-34
Telex: 53762 EFICO CH

United Kingdom
Viking Industries (UK), Ltd.
Bedfordshire, England MK 454 RS
Phone: LUTON 882345 (0582)
Telex: 825377 VIKING G

West Germany
Elpac, GmbH
8011 Putzbrunn, Munich
Phone: (089) 46 50 45
Telex: 05 22 378 INTRO D

Infratron, GmbH
8000 Numchen 50
Phone: 089-150 1001
Telex: 05 2150 90 INFM D

CIRCLE NO. 158

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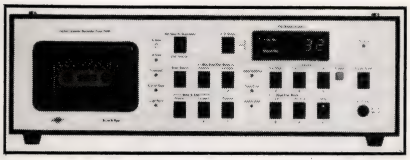
CIRCLE NO. 160

Recorder logs 500 kbytes on digital cassette



Up to 500 kbytes of data, transmitted over an IEC/IEEE or B&K interface bus, can be recorded on a standard digital cassette by the Type 7400 recorder. The 7400 incorporates full manual and remote control. Recording formats meet ECMA 34 and ECMA 41 standards. Since the recorder can be manually, as well as remotely, controlled, it can be used without a controller to record or read data in the field. A 4-digit tape location display indicates tape position. A search function finds data quickly, at a speed of 30 in./s. The recorder stores data at 1000 bytes/s with a tape speed of 15 in./s. Power can be supplied from an ac or dc source.

Bruel & Kjaer, 18, Naerum Hovedgade, 2850 Naerum, Denmark (45, 2) 80 05 00. Telex: 37316 bruka dk.

CIRCLE NO. 515

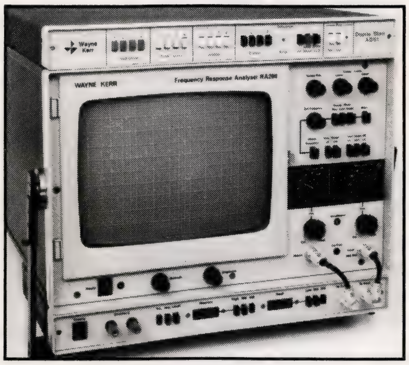
Tester checks DTMF tone levels

A pocket-sized go/no-go tester, the DTMF 206, determines the correct output level and frequency of tone telephones. Two sensitivity ranges test for correct output from a telephone instrument and the correct input level into a telephone exchange. If both tones are within preset limits of level and frequency, the instrument will indicate the appropriate character. A "low-battery" indicator shows when the unit's 9-V battery drops below 7 V. Sensitivity range is +4 to −25 dBm. Frequency tolerance is typically ±2.3%; input impedance, more than 30 kΩ.

Fematic A/S, 74 Kogevej, DK-2630 Taastrup, Denmark. 02-52 46 00. Telex: 16600 Fematic Taastrup.

CIRCLE NO. 516

Add-on adapts analyzer for telecomm work



An add-on component for the RA 200 frequency response analyzer, the ALM1, extends the basic instrument's performance into the telecommunications field. The adaptor measures impedance, return loss, frequency response and level. The analyzer and a digital store option help the ALM1 provide automatic curve plotting, storage and analysis for checking telephone networks or speech and music circuits. Input level range is −80 to +10 dB relative to 775 mV. Frequency range is 20 Hz to 20 kHz.

Wayne Kerr, Wilmot Breeden Electronics, Durban Rd., Bognor Regis, Sussex PO22 9RL, England. (0243) 825811. Telex: 86120.

CIRCLE NO. 517

Toroidal transformers supply 15 to 300 VA

A standard line of 50 different toroidal transformers, all with VDE approval, come in power ratings from 15 to 300 VA. Primary voltage is 220 V ac. The transformers are delivered with VDE marking according to VDE 0550, protection class II. Test voltage between primary and secondary windings is 3000 V ac.

Telema Elektronik GmbH, Bahnhofplatz 20, D-8034, Germering, b Munich, West Germany. (089) 843033/34.

CIRCLE NO. 518

Thermometer takes differential reading

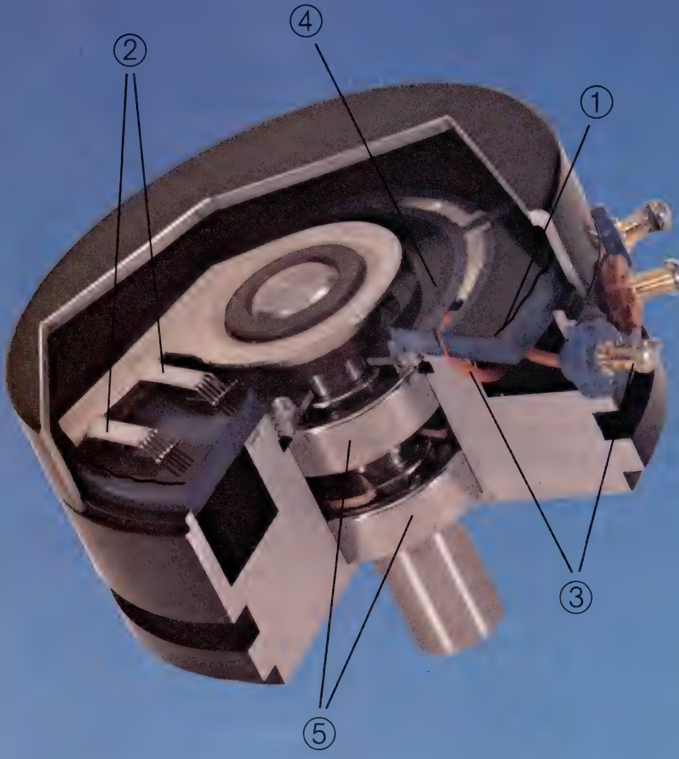
A pocket digital thermometer, Model GP300, equipped with an optional plug-in module, measures temperature differential. The module allows connection of two probes. The basic instrument covers a −30 to +300 C range. Accuracy is ±0.2% of reading (±1 C) with 1° C resolution. A wide range of plug-in thermocouple probes is available. A plug-in module allows connection of the instrument to recorders. A single 5.6-V battery powers the thermometer for up to 130 h. Size is 130 × 75 × 34 mm.

Polkinghorne Industries, Lillyhall Industrial Estate, Workington, Cumbria CA14 4JL, England. (0900) 3521/4. Telex: 64157.

CIRCLE NO. 519

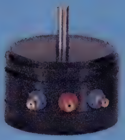
The new Quality Standard

With the Dinopot-HQ 5-System Novotechnik sets new standards for precision conductive-plastic potentiometers

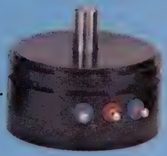


5 High-Quality characteristics:

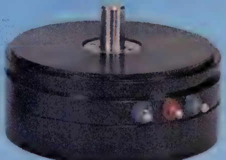
1. Linearization of the assembled unit using its own wiper
2. Elastomer-damped wiper
3. Stress-relieved connections to the resistance track
4. Conductive-plastic collector track
5. Exactly aligned precision bearings



Servo size 11
1 1/16" (27 mm) dia.
Series P 2500



Servo size 13
1 7/16" (36,5 mm) dia.
Series P 4500



Servo size 20
2" (50,8 mm) dia.
Series P 6500

In addition to high reliability this technology offers you some performance data unattained thus far: Operating life of better than 100 x 10^6 revolutions at up to 1500 rpm - Maximum operating speed of 10,000 rpm - Linearities of up to ± 0.025%. All this at a surprisingly low price.

The conductive-plastic potentiometers Dinopot-HQ5 come in three sizes with resistance values of 1 kΩ, 2 kΩ and 5 kΩ.

For more information please contact

CIRCLE NO. 161

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Offterdinger GmbH & Co.
Horbstrasse 12
D-7302 Ostfildern 1
West Germany

Telephone: 0711/412921
Telex: 07-23681

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Dovenetelstraat 25
Rotterdam-3012/NETHERLANDS
Tel. 229000 Telex 22047

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Tel. 930280 Telex 17944

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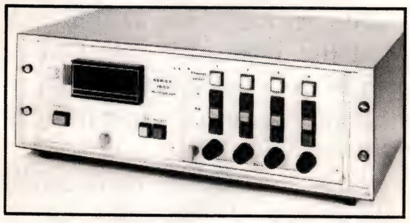
JAPAN

JAPAN ELECTRONICS CO., Ltd.
2-3-20 Nakamachi, Machida
Tokyo/JAPAN
Tel. 0427 (22) 2565

Unit drives 50 probes from one oscillator



A multiple-channel indicator, the Series 1500 Multigauge, drives up to 50 probes from one oscillator. The unit comes with a digital or analog display. Fully automatic scanning, with printout facilities, signal mixing and TIR (total indicated reading) boards are available. The unit's power supply requires 110 or 220/240 V ac at 50 or 60 Hz.

System E Controls, 1 New St., Leamington Spa, Warwickshire CV31 1HP, England. (0926) 29258. Telex: 311469.

CIRCLE NO. 520

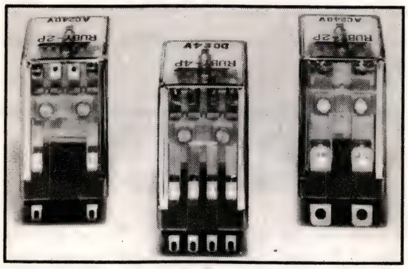
Scope extends test range to 30 MHz

A dual-trace oscilloscope, the Model CS-1830, covers a bandwidth of dc to 30 MHz to serve a broad spectrum of signal measurement requirements. Sweep and trigger display functions assist in the detailed analysis and measurement of complex waveforms. Vertical sensitivity is 2 mV/division. The scope uses a domed mesh PDA rectangular CRT measuring 120 × 96 mm. The CRT, which includes an internal graticule, minimizes parallax distortion. Other features include an automatic synchronization system, a single-sweep facility, a hold-off function, which assures stable synchronization for complex video or logic waveforms, and an "auto free-run" mode to assist voltage measurement and detection of input signals. Model CS-1830 operates from a user-selected input of 100, 120, 220 or 240 V at 50 or 60 Hz. The unit is manufactured by Trio-Kenwood of Japan.

House of Instruments, 34/36 High Street, Saffron Walden, Essex, CB10 1EP. England (0799) 22612. Telex: 81653.

CIRCLE NO. 521

Power relay switches up to 10 A



A miniature power relay, the Ruby, switches up to 10 A in industrial applications. A medium duty version carries up to 3 A on two or four pole changeover contacts. The heavy-duty 10-A model is restricted to two poles. All types are supplied with transparent dust covers and are available for plug-in, PC or direct-panel mounting. Coils can be wound for supplies in the 6 to 100-V dc or 6 to 240-V ac range. A full range of sockets, including solder terminal, screw terminal, PC and wrap-wire types is offered.

Londex, P.O. Box 79, Oakfield Rd., London, SE20 8EW, England. 01-659-2424. Telex: 262716.

CIRCLE NO. 522

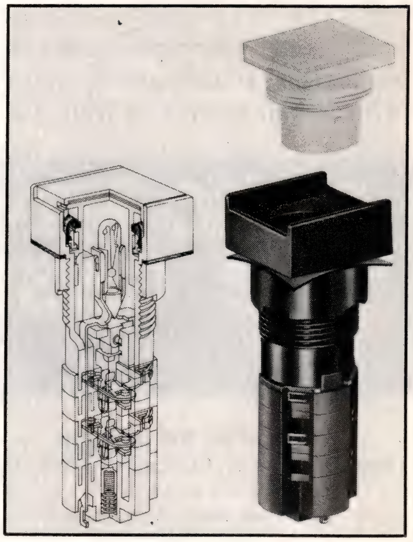
Counter combines timer and signal conditioning

A universal counter/timer, Model 5001, offers the versatility of several instruments in one. As a 10-MHz counter, the unit provides the functions of period and multiple period averaging, time-interval and multiple-time interval average, frequency-ratio measurements and unit or event counting. Two dc-coupled, high-impedance inputs are used to measure the time between successive pulses. For unit or event counting, Model 5001 displays the total number of rising edges appearing at one input. Information is displayed on an 8-digit LED readout. Front-panel indicators show overflow and gate-open conditions. The unit operates from 105 to 130 V ac or 210 to 250 V ac, 47 to 63 Hz.

Continental Specialties, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ, England. (0799) 21682. Twx: 817477.

CIRCLE NO. 523

Silicone rubber seals pushbutton switch

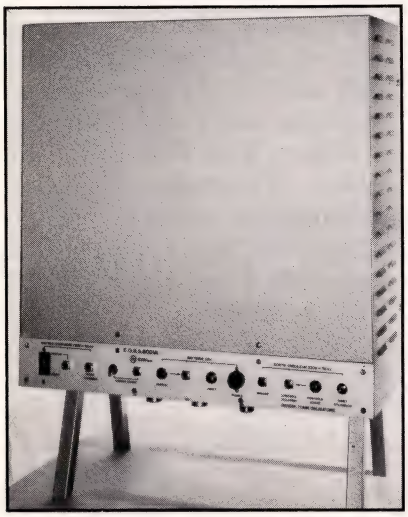


A silicone-rubber membrane, inside the Lumostast 75 pushbutton switch, seals the part against contamination. Unlike conventional sealing caps, the membrane permits access to lamps and legend inserts for replacement. The switch handles up to 4 A at 250 V through its spring-loaded, silver or gold-plated bridging contacts. A miniature T4.5 lamp or LED can be used for illumination.

RAFI, Postfach 20 60, D-7980, Ravensburg, West Germany. (0751) 89-1. Telex: 07-32866 rafi d.

CIRCLE NO. 524

Power system protects against line interruption



Uninterruptible, single-phase power systems (UPS), the SDGM series, provide a source of continuously available electrical energy to protect computers, peripherals and telecommunications equipment. Models are available with output powers of from 150 to 1200 VA in battery voltages of 24 and 48 V. The UPS consists of a regulated charger, an inverter and a group of batteries. Output is 220 V, single-phase at 50 Hz. Light indicators show charger, inverter and battery status, as well as equipment insulation breakdown. The cabinet can be wall-mounted or supplied with pedestals.

Sodilec, 7, Avenue Louise, 93360 Neuilly-Plaisance, France. 300-38-07. Telex: Sodilec 212932 F.

CIRCLE NO. 525

High-speed RAM uses less power

A high-speed 4-k × 1 static RAM, the Intersil 2147, uses less power than bipolar or earlier MOS static devices. Maximum access times are 70 ns (2147) and 55 ns (2147-3). The 2147 is a fully static memory; clock or timing strobes are not required. When the device is de-selected, power consumption is automatically reduced. Active mode consumption is 160 mA; standby mode, 20 mA. Only a single 5-V power supply is required. The device comes in an 18-pin ceramic DIP.

Rapid Recall, 6 Soho Mills, Wooburn Industrial Park, Wooburn Green, Bucks, England. (062 85) 24961. Telex: 849439.

CIRCLE NO. 526

Log amplifier aids radar systems

A "true" log amplifier, SL531, provides phase, frequency and amplitude information for radar and ECM systems. The monolithic chip has a low phase vs. amplitude coefficient—less then 0.1°/dB. The device has a phase change of only 3° in its dynamic input range of 70 dB. Small signal

TEAC MT-2: THE VALUE-PACKED CASSETTE DATA PACK

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An all-round winner, digital cassette is easier to handle, smaller, and has a higher storage capacity than floppy disk. Data transfer rate is approximately 40 times faster than Kansas City Standard audio cassettes.

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Easy microprocessor interface
The MT-2 is available with an optional interface developed by TEAC especially for this unit. It lets you connect the MT-2 to the bus lines of 8080, 6800 and Z-80 or equivalent microprocessors.

TEAC®

TEAC CORPORATION: 3-7-3 Naka-cho, Musashino, Tokyo, Japan Tel: (0422) 53-1111

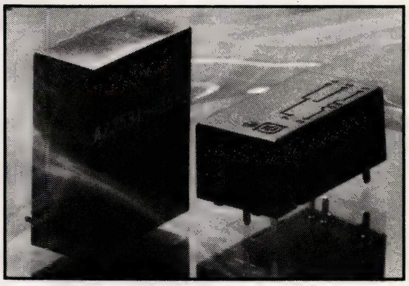
CIRCLE NO. 163

gain is 10 dB/stage over a frequency range extending to 500 MHz. The amplifier differs from previously available successive-detection log amplifiers in that it applies a log function to the i-f signal. It does not detect nor use the video signal. SL531 comes in an 8-pin TO-5 package and operates over a −55 to 125 C range.

Plessey Semiconductors, Cheney Manor, Swindon, England. (0793) 36251.

CIRCLE NO. 527

Sealed relays stay dry after full immersion



Low-profile relays, AZ2530 and AZ2531, use an encapsulation technique to withstand various manufacturing processes. The PC-mount parts are suitable for processes requiring full immersion of circuit boards during production. The relays are also capable of tolerating extreme environmental conditions. Type AZ2530 has one changeover contact; AZ2531, two changeover contacts.

Zettler Pressedienst, P.O. Box 202626, D-8000, Munich 2, West Germany, (089) 849056.

CIRCLE NO. 528

Op amp requires low input currents

A range of operational amplifiers, the CA080 Series, requires very low input currents, making them suitable for use with sensitive sources. The devices are constructed with the BiMOS process, a combining of bipolar and MOS devices on the same IC chip. The process gives the CA080 series low input offset parameters, a 3.5-MHz bandwidth, a high slew rate (14 V/μs typical) and low power consumption. Typical sources for the amplifiers include photodiodes, piezoelectric crystals and high-impedance transducers where high input bias current could introduce system errors or require additional circuitry.

RCA Solid State—Europe, Sunbury-on-Thames, Middlesex TW16 7HW. England. Sunbury-on-Thames 85511. Telex: 24246.

CIRCLE NO. 529

Wideband amp gives log and linear outputs

A wideband, direct-coupled amplifier provides both logarithmic and linear outputs from ac and dc input signals. Model 13-4614-00 is plug-in compatible with 2000 Series direct writing recorders, from which it receives its operating power. The amplifier may be used with any recorder or readout device that accepts a ±2.5 V dc input. In ac log operation, nine 50-dB sensitivity ranges in 10-dB steps from 100 V rms to 10 mV rms give a measurement range of 130 dB. Frequency response is flat to within ±1 dB from 10 Hz to 100 kHz. In dc log operation, five 50-dB sensitivity ranges in 10-dB steps from 100 V to 1 V give a total range of 90 dB. The amplifier performs as an ac level converter in its ac linear mode. the output will be directly proportional to incoming signal rms levels based on a sinusoidal input waveform.

Gould Instruments, Roebuck, Rd., Hainault, Essex 1G6 3UE, England. 01-500 1000. Telex: 263785.

CIRCLE NO. 530

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Just draw one of our 45 MHz monolith filters and match it with your 800 MHz receiver for winning performance and economy. What a pair! Two-pole and four-pole models offer 60dB attenuation. Models 2843A, 2844A and 4371F are now available in production quantities. No matter how tough your communications requirements, PTI has them pegged. Write or call for detailed data sheets.

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(305) 298-2000

CIRCLE NO. 162

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Philips Industries, Electronic
Components and Materials Division,
Eindhoven, The Netherlands

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CIRCLE NO. 159

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Type 173D solid-electrolyte TANTALEX® capacitors in bullet-nose molded cases.

- Lead-taped and reeled for use in automatic insertion equipment.
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4SE-9122R1

For complete technical data, write for Engineering Bulletin 3533.10 to Technical Literature Service, Sprague Electric Company, 347 Marshall Street, North Adams, Mass. 01247.

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CIRCLE NO. 18

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recognized

87 RECOGNIZED SWITCHERS
FROM 30 TO 300 WATTS

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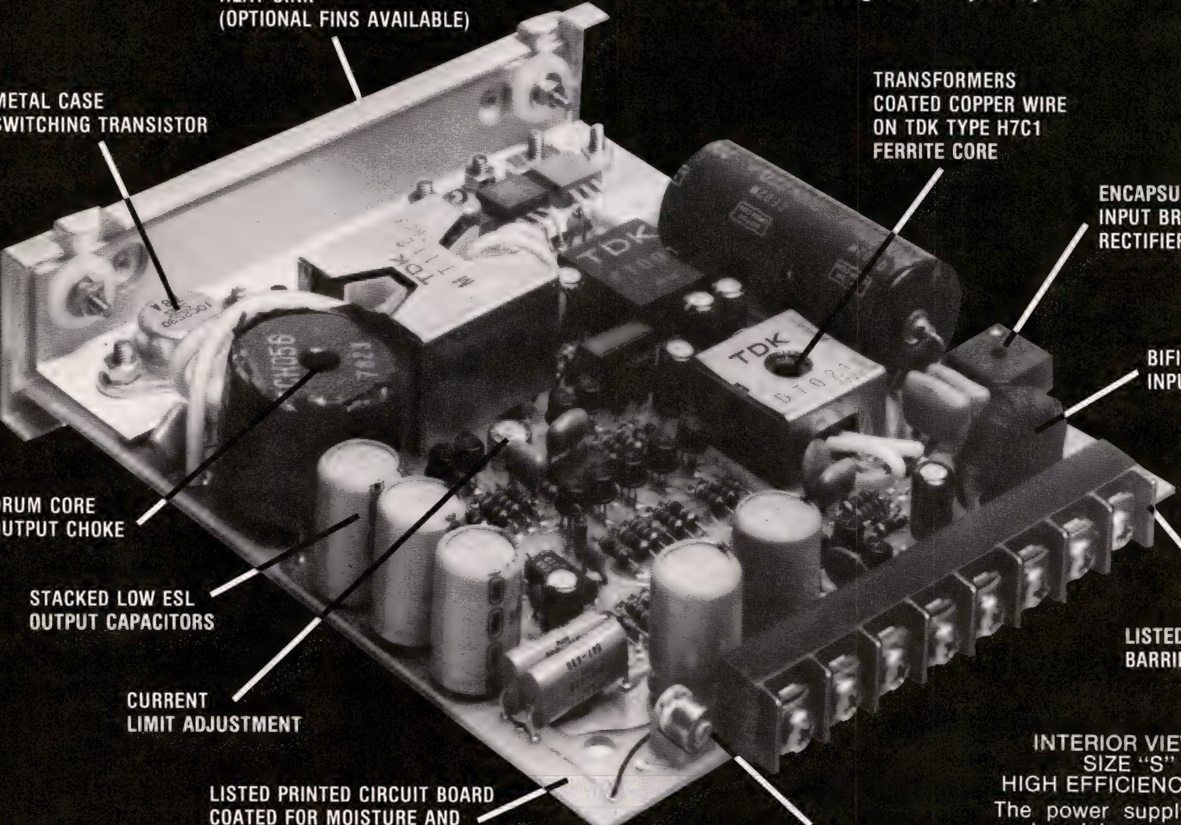

INTERIOR VIEW OF THE
SIZE "S" (30W)
HIGH EFFICIENCY SWITCHER

The power supply is normally enclosed in a one piece ventilated aluminum housing for EMI shielding (meets VDE 0875/7.71 and VDE 0871/6.78 for radiated emissions).

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CIRCLE NO. 19

WashingtonReport

Post Office wants its own EMS capability

While the independent Postal Rate Commission is working out the ground rules for an Electronic Message System (EMS), the U.S. Postal Service has been lobbying hard for permission to launch its own version of the system. It may be winning the battle.

Under a plan approved earlier this year by the rate commission, a contract for the EMS service is supposed to go to a private computer-mailing company, which would accept mass mailings and transmit them from one location to regional post offices, where they would be printed, stuffed into envelopes and addressed for delivery. Such a system would compete with other data-transmission systems being planned or operated by private companies.

However, the plan carried by only a slim margin and a stormy debate ensued. As a result, changes have been made and others are likely—all to let the postal service compete with whatever private company gets the EMS contract. Meanwhile, Postmaster General William Bolger, who has called the post office's active participation in electronic mail "a key to the future of the postal service," reportedly has won considerable congressional support.

Atari loses battle against TI-modulator waiver

Atari Inc. has lost its bid to have the FCC overturn a waiver it granted last year to Texas Instruments for a stand-alone rf modulator used with TI's personal computer.

Arguing that the waiver would jeopardize television reception and unfairly penalize the personal-computer makers who met FCC rules without a waiver, Atari said the FCC in effect changed its rules without benefit of a formal rulemaking proceeding. The commission rejected that argument, and said its own investigation indicated TI computers operated with rf modulators under the waiver wouldn't harm TV reception.

TI obtained the waiver after its combined computer-modulator arrangement failed FCC tests, a move that allowed the company to proceed with plans to market a personal computer that uses a regular TV receiver for display purposes.

OSHA, SBA come together on rules

The antagonism that has long embroiled small businesses and the Occupational Safety and Health Administration (OSHA) may subside dramatically in coming months. The Small Business Administration has exchanged a memorandum of understanding with OSHA by which the watchdog agency agrees to work with SBA to reduce the burden of its regulations on smaller firms.

Under the agreement, OSHA will seek out small businesses adversely affected by its rules and get these firms involved in the rulemaking activities. Among the possible outcomes are two-tiered regulations that apply differently to large and small firms and looser compliance schedules for small firms when the rules cannot be tailored to business size.

The two agencies also plan joint financial and technical assistance to help small companies implement health and safety regulations.

Timetable relaxed on computer-interference rules

The Federal Communications Commission has modified the rules it issued last November to reduce the possibility of computer's causing interference with nearby broadcast receivers. While the technical standards involved do not change, computing-equipment manufacturers now have more time to meet the rf radiation standards.

Under the modified rules, manufacturers of large business computers will have until 1983 to verify to the commission that products already in production meet the technical standards. But any computers introduced after Oct. 1, 1981, will have to meet the regulations before they can be sold.

Companies producing personal computers or other digital devices intended mostly for use in residences will have to meet FCC specs by January, 1981, without exception. The initial version of the rules would have had all computers meeting the technical specifications by July, 1980.

In addition, any computers currently in production that do not meet the new standards will have to carry labels warning the owner that use of the device in a residential area could create an interference problem, which the owner would have to correct at his own expense.

FCC okays AM stereo—but only with Magnavox system

In a move guaranteed to stir controversy and possibly some lawsuits, the Federal Communications Commission has given AM broadcasters the go-ahead to start sending their signals in stereo—provided they use a broadcasting-receiving system developed by Magnavox to do it.

The decision comes after several years of study and prompting by the broadcast industry, which believes that stereo transmission will help AM stations make up some of the ground lost to FM stations already offering stereo.

Having decided that a single mandatory system would be preferable to having equipment makers struggling in the marketplace for dominance, the commission settled on Magnavox, citing slight technical superiority. Harris Corp., Motorola, Belar Electronics and Kahn/Hazeltine Electronics were passed over.

Although all but Kahn/Hazeltine had earlier indicated they favored the single-system alternative, there are indications the FCC's selection of the Magnavox system could bring an appeal to the courts. The commission defended the concept by arguing that a shakedown of the systems in the open market would only delay AM stereo further.

NBS develops 'invisible sentinel' for DOD

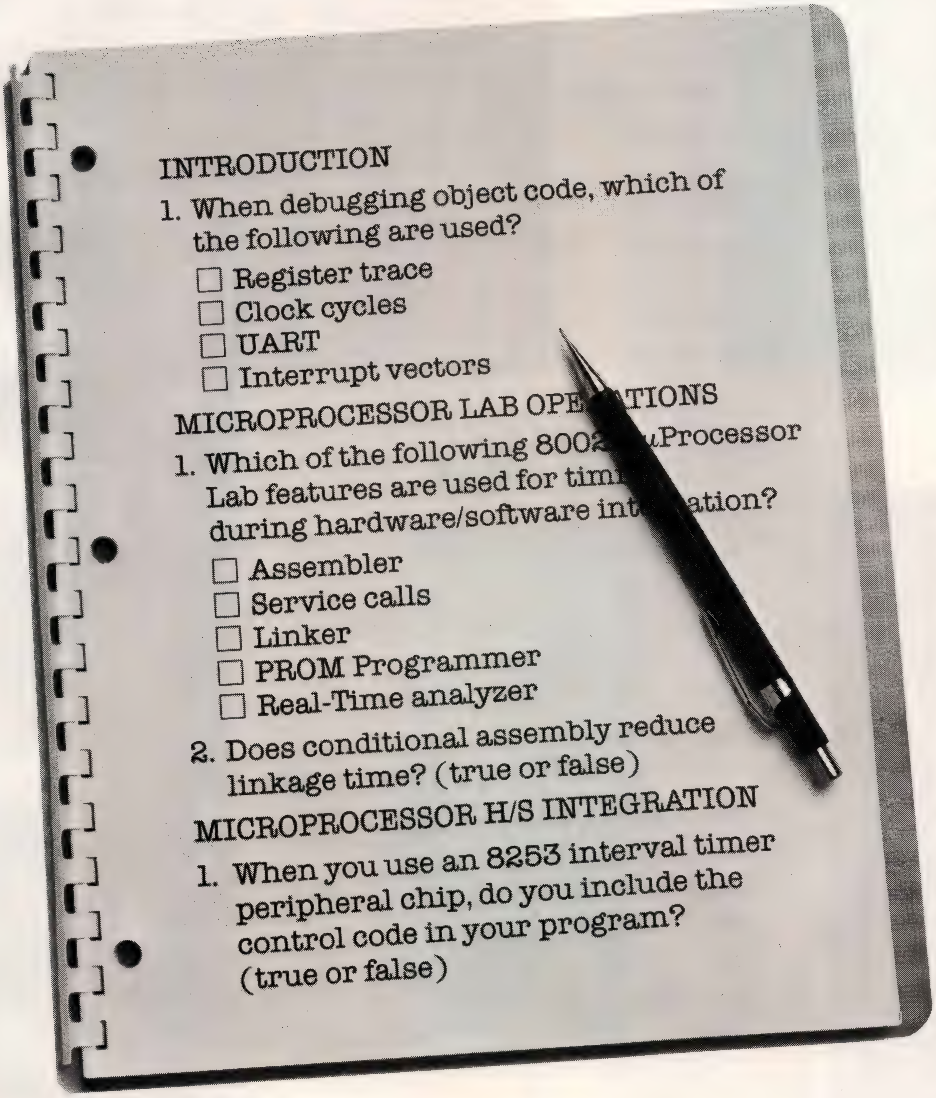
A low-cost acoustic-interferometric technique for detecting swimmers and waders in restricted shallow water has been developed by the National Bureau of Standards for the Department of Defense.

A continuous-wave acoustic source emits harmonic-free energy, which is received by a group of sensors placed along the shore. The phase and magnitude of the sound waves are continuously monitored in the undisturbed water environment. An intruder alters both the phase and magnitude of this steady-state acoustic field. NBS scientists discriminate between intruders and natural turbulence by characterizing the "signatures" of each.

Capital Capsules

The Air Force has awarded AAI Corp. (Baltimore, MD) $6-million more to produce about 800 additional radar testers. **The units are microcomputer-controlled testing modules that simulate and measure parameters of X-band radar systems**....Air Force officials also announced they are seeking contract sources for a **fiber-optic multiplex bus receiver microcircuit to operate with an interface device being built by Harris Corp.** (Melbourne, FL) for the Air Force. The circuit must be able to operate in the 1-Mbit-per-second range....The Army Armament Research and Development Command is seeking a contract source for a **single-chip μC designed for use in a new generation of land mines.**

Test your microprocessor design IQ.


INTRODUCTION

1. When debugging object code, which of the following are used?
   - ☐ Register trace
   - ☐ Clock cycles
   - ☐ UART
   - ☐ Interrupt vectors

MICROPROCESSOR LAB OPE ATIONS

1. Which of the following 8002 uProcessor Lab features are used for tim during hardware/software int ation?
   - ☐ Assembler
   - ☐ Service calls
   - ☐ Linker
   - ☐ PROM Programmer
   - ☐ Real-Time analyzer
2. Does conditional assembly reduce linkage time? (true or false)

MICROPROCESSOR H/S INTEGRATION

1. When you use an 8253 interval timer peripheral chip, do you include the control code in your program? (true or false)

How many questions did you miss? One? Two? Three or more? Well, no matter how you did, this little test proves one thing: The field of microprocessor design is changing so rapidly, it's a real challenge just to stay on top.

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1104	Chicago, IL	August 25-29

Microprocessor Hardware/Software Integration Techniques

1400	Washington, DC	June 23-27
1401	Boston, MA	July 14-18
1402	Santa Clara, CA	July 28-August 1
1403	Chicago, IL	August 11-15
1404	Boston, MA	August 25-29

Microprocessor Lab Operations

1200	Boston, MA	June 2-6
1201	Chicago, IL	June 9-13
1202	Washington, DC	June 16-20
1203	Santa Clara, CA	June 23-27
1204	Chicago, IL	July 21-25
1205	Santa Clara, CA	August 4-8
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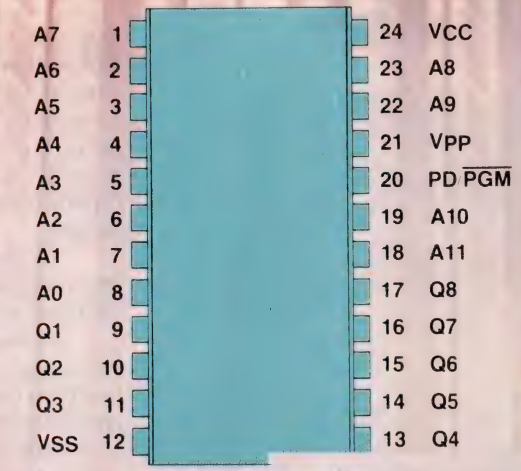
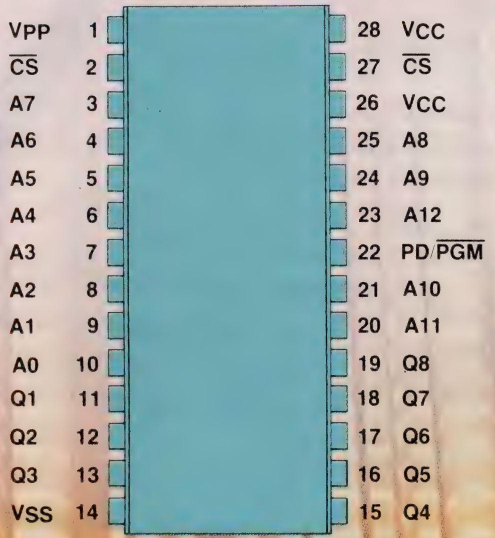
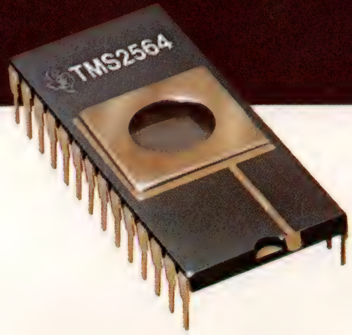
TMS 2532
32K EPROM



TMS 2564
64K EPROM



MOVING AHEAD IN MEMORIES



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TMS2564 is offered in a 600-mil, 28-pin dual-in-line package. But, it's compatible with industry standard 24-pin 64K ROMs, as well as less dense EPROMS.

This is because pins 3 through 26 of the TMS2564 are compatible with pins 1 through 24 of the 24-pin devices. Compatibility is enhanced by reserving both pins 26 and 28 for the 5-V supply. So, with a supply trace to pin 26, both 24 and 28-pin devices can be used, with no jumpering.

Fully static

Like all TI EPROMS, the TMS2564 maintains the fully static tradition that makes designing easier.

No timing signals. No clocks. No strobes. No refresh. No problems. Simply, cycle time equals access time.

Lowest power ever

Operating at an access time of 450 ns with a power dissipation of only 840 mW maximum or less than 13 μW per bit, it's the lowest power per bit ever achieved in EPROMS.

TI'S GROWING EPROM FAMILY

Device	Description	Power Supply	Max Power (0°C) Operating	Standby	Access Time
TMS2564	64K	5 V	840 mW	131 mW	450 ns
TMS25L32	32K	5 V	500 mW	131 mW	450 ns
TMS2532	32K	5 V	840 mW	131 mW	450 ns
TMS2516-35	16K	5 V	525 mW	131 mW	350 ns
TMS2516	16K	5 V	525 mW	131 mW	450 ns
TMS2508-25	8K	5 V	446 mW	131 mW	250 ns
TMS2508-30	8K	5 V	446 mW	131 mW	300 ns
TMS2716	16K	+12, ±5 V	720 mW	—	450 ns
TMS27L08	8K	+12, ±5 V	580 mW	—	450 ns
TMS2708	8K	+12, ±5 V	800 mW*	—	450 ns
TMS2708-35	8K	+12, ±5 V	800 mW*	—	350 ns

*$T_A = 70°C$

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CIRCLE NO. 21

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Part #	16	IH6116	IH6216	DG506	DG507	HI-506	HI-507
	8	IH6108	IH6208	DG508	DG509	HI-508A	HI-509A
$I_{D(on)}$ Leakage Current	16	100nA	100nA	300nA	200nA	500nA	250nA
X	8	100nA	50nA	200nA	100nA	250nA	N.A.
$R_{DS(on)}$ Resistance	16	700Ω	700Ω	500Ω	500Ω	400Ω	400Ω
=	8	400Ω	400Ω	500Ω	500Ω	1800Ω	1800Ω
Error Voltage Error	16	70μV	70μV	150μV	100μV	200μV	100μV
	8	40μV	20μV	100μV	50μV	450μV	N.A.
Power Dissipation @+25°C	16	4.5mW	4.5mW	300mW	300mW	60mW	60mW
	8	4.5mW	4.5mW	240mW	240mW	45mW	45mW

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2 of 8	Ceramic	−55° to +125°	IH6208MDE	13.75
1 of 16	Plastic	0 to 70°	IH6116CPI	12.50
1 of 16	Ceramic	−55° to +125°	IH6116MDI	29.90
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2 of 16	Ceramic	−55° to +125°	IH6216MDI	29.90

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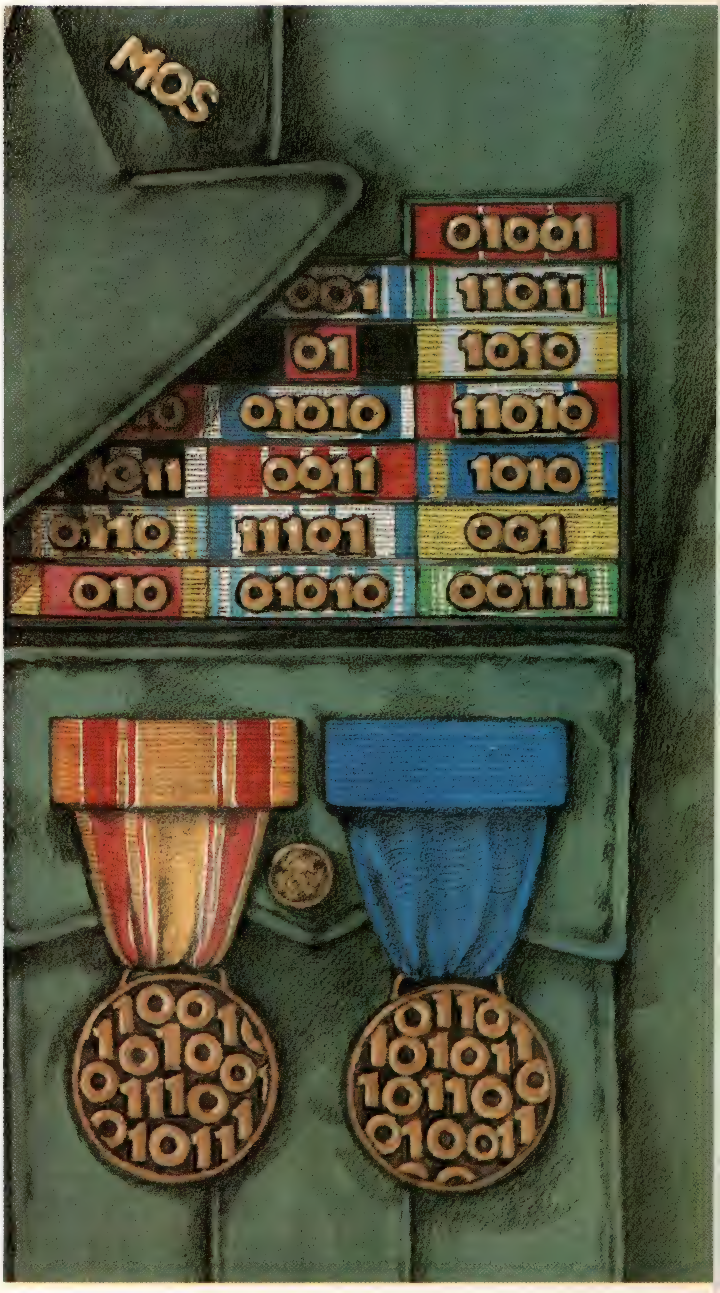
Besides packing enough density to quadruple the memory capacity of the 8048, a new single-chip microcontroller works on bits and bytes.

Microcontroller doubles as Boolean processor



The latest single-chip microcontroller family from Intel brings forth a controller whose dual personality sets it well apart. Based on HMOS, the 8051 (and family) packs enough density to offer four times the memory of the 8048; in addition, the instruction set is much more comprehensive. Not only that, the 8051 can also handle Boolean variables—a major breakthrough for microcomputers that makes the 8051 a byte and bit processor.

Boasting 60,000 transistors, compared to the 8048's 17,000, the 8051 offers 4 kbytes of ROM and 128 bytes of RAM. Other members of the new HMOS family include the 8751 EPROM version, meant for prototyping, and the 8031, which relies on external program memory. All three chips are pin-compatible; they can address 64 kbytes each of program and data memory.

But while the 8051 is a capable processor for 8-bit binary as well as BCD arithmetic, along with 8-bit logic operations, the real standout feature is its ability to handle Boolean variables. Individual bits in special-function registers (SFRs) and 128 software flags can be the operands for logical conditional-branch and transfer operations.

Although integrated with the 8051's architecture (Fig. 1), the Boolean processor may be regarded as an independent bit processor. It has its own instruction set, its own accumulator (the carry flag), its own bit-addressable RAM and its own I/O. The bit-manipulation instructions allow the direct addressing of 128 bits within the internal data RAM and 128 bits within the SFRs.

On any addressable bit, the Boolean processor can perform the following bit operations: Set, Clear, Complement, Jump If Set, Jump If Not Set, Jump If Set Then Clear, and Move To/From Carry. Be-

Bob Koehler, Marketing Product Manager
Intel Microcontroller Operation
3157 N. 34th Dr., Phoenix, AZ 85017

tween any addressable bit (or its complement) and the carry flag, the Boolean processor can perform the bit operations of AND and OR, the result going into the carry flag.

The bit-manipulation instructions provide excellent code and speed efficiency in bit-intensive applications, such as controlling the 8051's on-chip peripherals. The Boolean processor also provides a direct way to convert into software the logic equations used in random-logic design. Complex combinatorial-logic functions can be resolved without extensive data movement, byte masking and test-and-branch trees (Fig. 2).

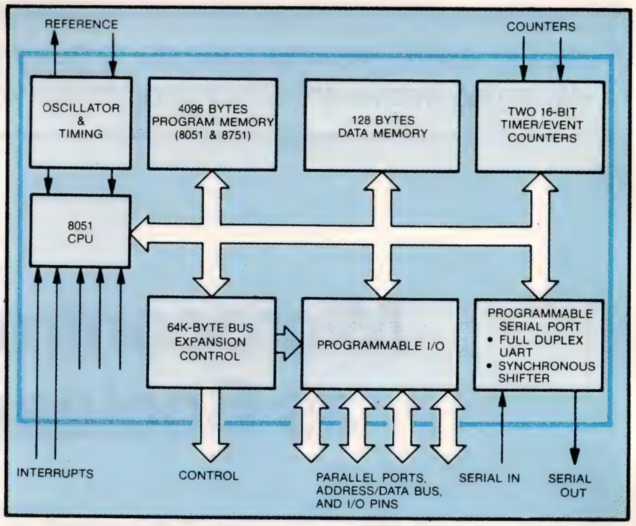
A better architecture

The 8051 CPU manipulates operands in four memory spaces: the 64-kbyte program memory, 64-kbyte external data memory, 16-bit program counter and 384-byte internal data memory, which is further divided into the 256-byte internal data RAM and 128-byte special-function register (Fig. 3). Internal data RAM contains four register banks of eight registers each as well as the stack and 128 addressable bits.

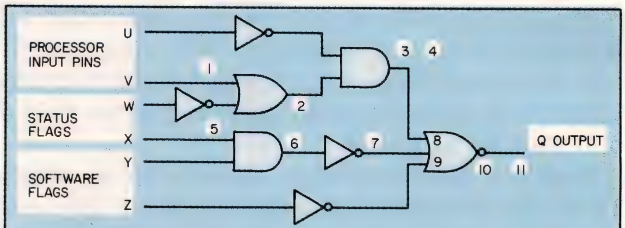
Stack depth is limited only by the available internal data RAM; the starting address is determined by an 8-bit stack pointer. Currently, the lower 128 bytes of internal RAM address space are filled with on-chip RAM—the upper 128 bytes can be added in later products without affecting existing software.

All registers (except for the program counter) reside in the SFR address space. Memory-mapped, they include arithmetic registers, pointers, I/O ports, interrupt system registers, timers and the serial port (Fig. 4).

Users can directly address 128 bits in the SFR address space. The 8051 uses only 20 of the 128 bytes in the space for SFRs, so future members of the microcontroller family have room for up to 108 more

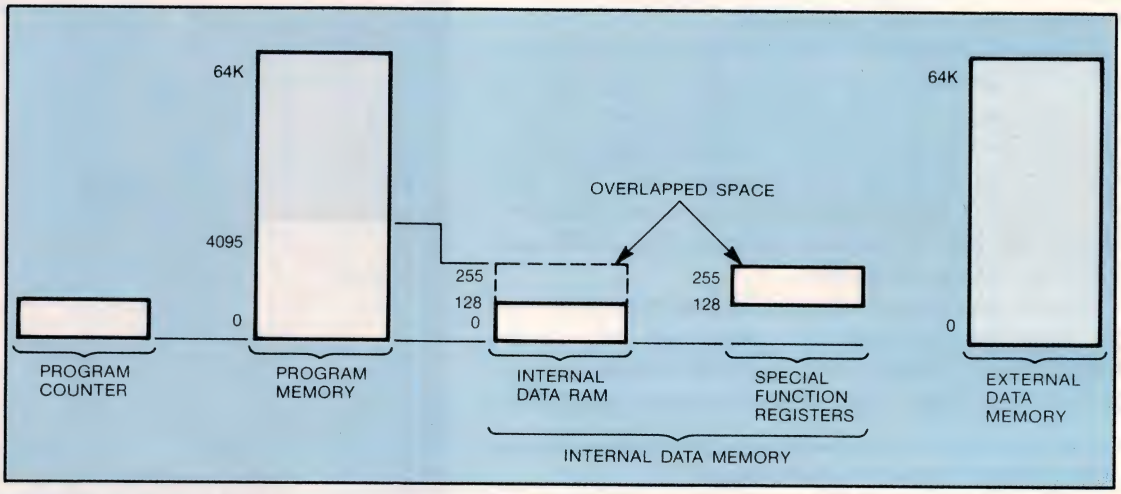


1. **The architecture of the 8051 family is strongly bus-oriented (white). On-board counters and a programmable serial port enhance the chip's controller capabilities.**



```
LINE No.   MNEMONICS    COMMENTS
   1       MOV  C,V     V→C
   2       ORL  C,/W    C OR NOT W→C
   3       ANL  C,/U    C AND NOT U→C
   4       MOV  FO,C    C→FO
   5       MOV  C,X     X→C
   6       ANL  C,Y     C AND Y→C
   7       CPL  C       NOT C→C
   8       ORL  C,FO    C OR FO→C
   9       ORL  C,/Z    C OR NOT Z→C
  10       CPL  C       NOT C→C
  11       MOV  Q,C     C→C
```

2. **The Boolean operations built into the 8051 directly solve problems like this example, which might represent timing control for a keyboard. Variables in the program and Boolean operations are cued to the schematic (white).**



3. **Both the on-board data and program memories (white) can be supplemented by external RAM to provide about 64 kbytes for both types.**

counters, ports, a/d converters and the like, without affecting existing software.

The 8051's program-memory space is not paged and accommodates relocatable code. Conditional branches are offset to the program counter. The register-indirect jump permits branching relative to a 16-bit base register; an 8-bit index register provides offset. Sixteen-bit jumps and calls allow branching to any location within the contiguous 64-kbyte program-memory address space.

Addressing modes for all needs

Source operands can be addressed five ways: *register, direct, register-indirect, immediate* and *base-register plus index-register indirect.* The first three can be used for addressing destination operands. Most instructions have a Destination, Source field that specifies data type, addressing methods and operands. Except for move instructions, the destinaion operand is also a source operand.

The *register, direct,* and *register indirect* addressing modes access registers in the register bank, located in internal data RAM. *Direct* and *register-indirect* modes access the 128 bytes of internal data RAM while *direct* addressing provides access to the SFRs. To access external data memory, *register-indirect* addressing is used, while the fifth mode, *base-register plus index-register indirect,* provides access to lookup tables residing in program memory.

The 8051's internal ROM, RAM, SFRs, ALU and external data bus are all 8 bits wide, but the processor can handle single-bit, 4-bit and 16-bit data types, too. Facilities for 8-bit data transfer, logic and integer-arithmetic operations are supplemented by data transfer, logic and conditional branch operations performed directly on Boolean variables.

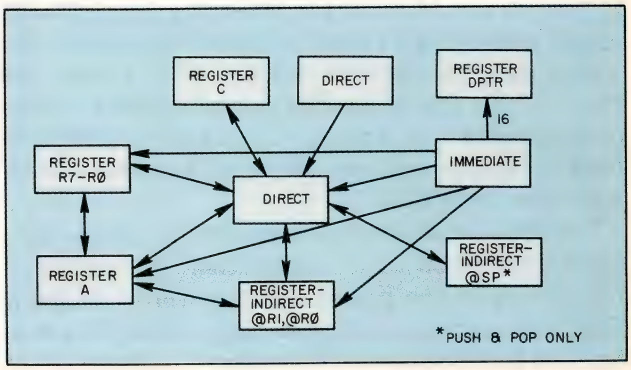
The instruction set, while similar to that of the 8048 family, is enhanced to allow expansion of on-chip CPU peripherals, to sharpen byte efficiency and execution speed, and to contain new high-power operations and new addressing modes that provide a more symmetrical instruction set. It includes 49 single-byte, 45 double-byte and 17 triple-byte instructions. At a 12-MHz clock rate, 64 of the instructions execute in 1 μs and 45 in 2 μs while multiplications and divisions take 4 μs.

Comprehensive Move instructions

The 8051 boasts other improvements as well. For one thing, data transfer, logic manipulation, arithmetic processing and real-time control capabilities have all been enhanced. Lookup tables, residing in program memory, can be accessed by indirect moves, which enables a byte to be transferred from the location whose address is the sum of a 16-bit base register and the 8-bit index register. This feature is convenient for programming translation algorithms such as ASCII-to-seven-segment conversions.

Arithmetic registers	:	Accumulator, B register, program-status word
Pointers	:	Stack pointer, data pointer (high and low)
Parallel-I/O ports	:	Port 0, port 1, port 2, port 3
Interrupt system	:	Interrupt-priority control, interrupt-enable control
Timers	:	Timer mode, timer control, timers 0 and 1 (high and low)
Serial-I/O port	:	Serial control, serial-data buffer

4. Special-function registers, shown in Fig. 3, are used for arithmetic, I/O, timers and the interrupt system.



5. Move operations are possible from nearly any storage location to nearly any other. Except where noted, all moves operate on bytes.

A byte location within a 256-byte block of external data memory can be accessed through *register-indirect* addressing via an 8-bit base register. Furthermore, any location within the full 64-kbyte external data memory address space can be accessed through *register-indirect* addressing via a 16-bit base register.

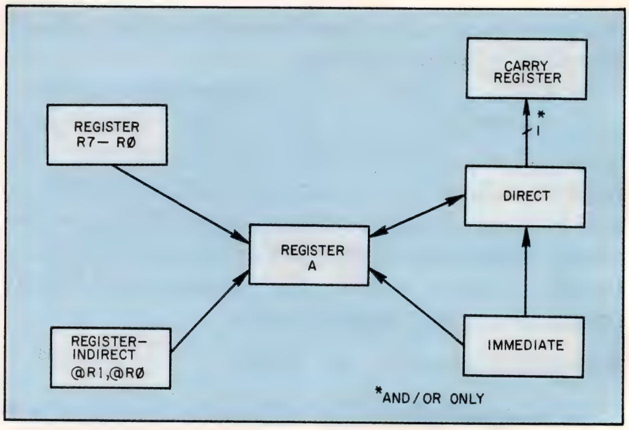
Byte-constant moves (or immediate moves) and byte-variable moves are highly orthogonal (Fig. 5). In other words, a byte operand located anywhere in the internal data memory can be transferred to nearly any other location in the memory by a single instruction, as can immediate operands. The direct-address-to-direct-address move permits the value in a port to be moved to the internal data RAM without using any registers or the accumulator.

In addition, the accumulator can be exchanged with a register in a selected register bank, with a *register-indirect*-addressed byte in the internal data RAM, or with a *direct*-addressed byte in the internal data RAM or SFR. The least significant half-byte of the accumulator and of a *register-indirect*-addressed byte in internal data RAM can also be exchanged.

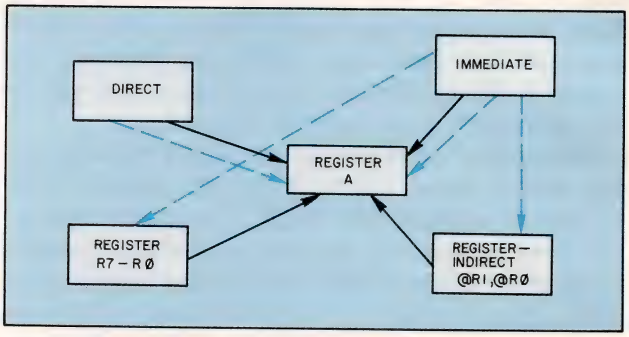
The 8051 permits a second operand to perform the logic operations of AND, OR and XOR on the accumulator. This second operand can be an immediate value, a register in a selected register bank, a *register-indirect*-addressed byte of internal data RAM, a *direct*-addressed byte of internal data RAM or an SFR.

The three logic operations can also be performed on a *direct*-addressed byte of internal data RAM or an SFR, using the accumulator as the second operand. Any bit anywhere in the internal data RAM or SFRs can be set, cleared or complemented using the logic operations with *immediate*-addressing to *direct* addressing (Fig. 6). The remaining logic operations work only on the accumulator.

Only unsigned binary-integer arithmetic is performed in the ALU. In the two-operand operations of add, add-with-carry and subtract-with-borrow, the accumulator is the first operand and receives the result of the operation. The second operand can be an immediate byte, a register from a selected register bank, a *register-indirect*-addressed byte or a *direct*-addressed byte (Fig. 7).



6. Logic operations include many source and destination locations and—except where noted—AND, OR and XOR.



7. Various operations involve different registers: Add, Add With Carry and Subtract With Borrow are indicated by black lines, Compare And Jump If Not Equal by colored lines.

The 8051 handles two's-complement-integer (i.e., signed) addition and subtraction by software-monitoring of the program-status word's overflow flag. One operation arithmetically similar to a subtraction is the instruction Compare And Jump If Not Equal, which performs a conditional branch if a register in a selected bank (or an *indirect*-addressed byte of internal data RAM) does not equal an immediate value, or if the accumulator does not equal a byte of *direct*-addressable internal data RAM or an SFR.

Three arithmetic functions operate exclusively on the accumulator: Decimal Adjust For Addition, Jump If Accumulator Is Zero and Jump If Accumulator Is Not Zero. Conditional branches may be taken, based on the value in the accumulator, whether zero or not.

Software counters are easy to implement with the 8051 because increment and decrement operations can be performed on the accumulator, a register in a selected register bank, an *indirect*-addressed byte in the internal data RAM, or a byte in the *direct*-addressed internal RAM or SFR. The operation Decrement And Jump If Not Zero facilitates efficient loop control. This operation can test a register in a selected register bank, any SFR, or any byte or internal data RAM accessible through *direct* addressing, and then force a branch if it is not zero. In addition, the 16-bit data pointer can be incremented.

Peripherals galore

Counting, timing and communications in a realtime, priority-oriented environment are the keystones of control applications. External events and peripherals require asynchronous servicing by the CPU. A sophisticated nested interrupt system ties these asynchronous activities to regular program execution with response latencies of 3 to 7 μs.

The 8051 services interrupt requests coming from five sources—two via the INT 0 and INT 1 pins, one from each of the two internal counters and one from the serial-I/O port. Each vectored interrupt accesses a location in program memory for its service routine. Each of the five interrupt sources can not only be assigned to one of two priority levels but can also be enabled and disabled independently. Finally, all enabled sources can be disabled or enabled globally (Fig. 8).

The 8051 has instructions that treat its 32 I/O lines as 32 individually addressable bits or as four parallel 8-bit ports (Fig. 9). Each pin of port 0 can be configured as an open drain output or as a high-impedance input. Ports 1, 2, and 3 are quasi-bidirectional buffers that can sink or source one TTL load. Port 0 also provides a microprocessor bus with multiplexed low-order address and data; it serves as an interface with standard MCS-85 memories and MCS-80 peripherals. Port 2 provides the high-order address bus needed to expand the 8051 with external program or data memory. The bus driver can sink or source two TTL loads.

At 12 MHz, the program-memory cycle is 500 ns and the access times from stable address and program-store enable are approximately 320 ns and 150 ns, respectively. For external memory, the cycle is 1 μs and the corresponding access times are approximately 600 ns and 250 ns (pins $\overline{RD}$ and $\overline{WR}$ of port 3).

The remaining pins of port 3 can be used for other functions: Interrupt-request inputs (INT0 and INT1), counter inputs (T0 and T1) and the serial port's receiver input (RXD) and transmitter output (TXD).

Timing is essential

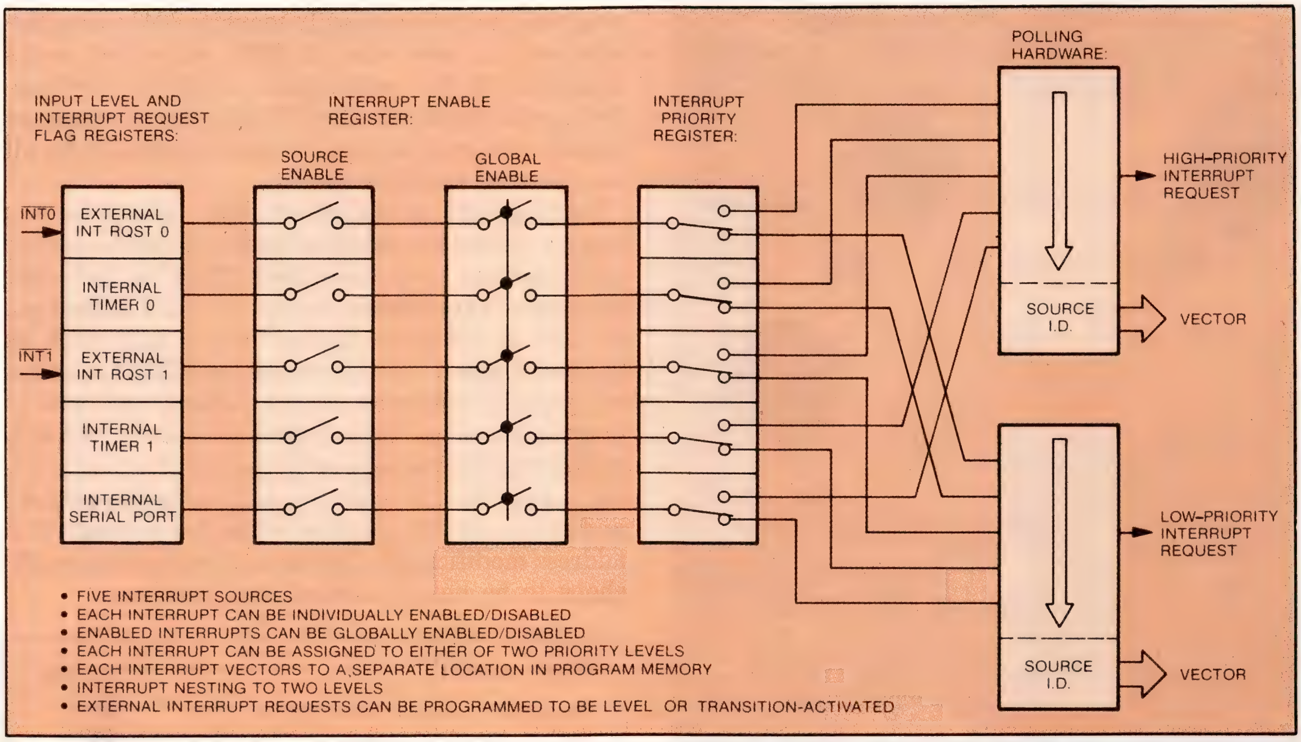
The 8051 contains two 16-bit counters for measuring time intervals, counting events, measuring pulse widths and generating periodic interrupt requests—a big help in control applications. Each can be programmed to operate in one of three modes: Mode 0 is similar to an 8038's 8-bit timer with prescaler and 8-bit event counter; mode 1 is a 16-bit time-interval or event counter; and mode 2 is an 8-bit time-interval or event counter with automatic reload upon overflow. Counter 0 can also be programmed in a fourth mode that divides it into one 8-bit time interval or event counter and one 8-bit time-interval counter.

The 8051's counters not only offer flexibility and 16-bit precision, they also can handle very high input frequencies. For external inputs, the frequency range is from 0 Hz to 0.5 MHz; when programmed for an input of the internal oscillator, they cover 0.1 to 1 MHz. To measure pulse width directly, an external input can be gated to the counter by a second external source. The counters are started and stopped under software control. Each counter sets its interrupt request flag when it overflows from all ONEs to all ZEROs, or to the auto-reload value.

A serial port for communictions

The 8051's serial-I/O port can link not only peripheral devices but also multiple 8051s, using standard asynchronous protocols in a full-duplex operation. The serial port also has a synchronous mode, using CMOS and TTL shift registers to expand I/O lines. A serial-communications interface in hardware saves ROM code and permits a much higher data rate than a software-controlled interface. In response to a serial-port interrupt request, the CPU can service the serial link simply by reading from or writing to the serial port's buffer.

The receiver is double-buffered to eliminate the overrun that would occur if the CPU failed to respond to the receiver's interrupt before the beginning of the next frame. Furthermore, the 8051 offers false-start-bit rejection on received frames and, for noise rejection, takes a best-two-out-of-three poll on three samples near the center of each received bit. When interfacing with standard UART devices, the serial channel can be programmed to transmit or receive a 10-bit frame at communication rates of 122 to 31,250 baud; 11-bit frames can, in addition, be transmitted at 187,500 baud. The interprocessor-communications mode is similar to the two standard UART modes, but provides automatic wakeup of



- FIVE INTERRUPT SOURCES
- EACH INTERRUPT CAN BE INDIVIDUALLY ENABLED/DISABLED
- ENABLED INTERRUPTS CAN BE GLOBALLY ENABLED/DISABLED
- EACH INTERRUPT CAN BE ASSIGNED TO EITHER OF TWO PRIORITY LEVELS
- EACH INTERRUPT VECTORS TO A SEPARATE LOCATION IN PROGRAM MEMORY
- INTERRUPT NESTING TO TWO LEVELS
- EXTERNAL INTERRUPT REQUESTS CAN BE PROGRAMMED TO BE LEVEL OR TRANSITION-ACTIVATED

8. The 8051 family's interrupt system is unusually versatile. Global and individual enables can be combined with both software and hardware-priority assignments.

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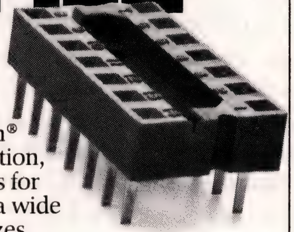

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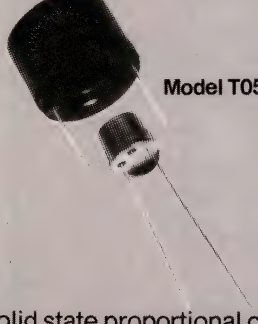
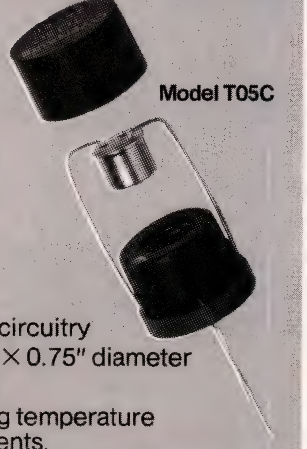

Model T05P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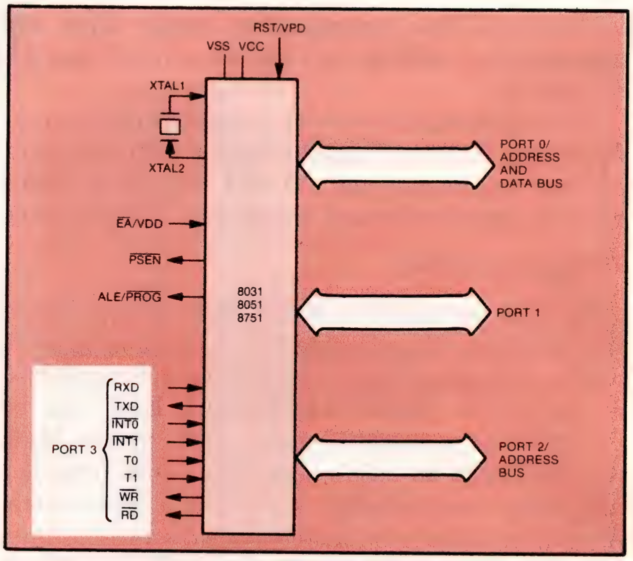

9. Four 8-bit ports (white) take up most of the 8051's 40 pins. The data bus is split between port 0 and port 2.

slave processors.

Even the best μC is in trouble without development support, but the 8051 family, new as it is, can count on Intel's line of Intellec development systems. Support software, development systems and a user library stocked with 8051 utility and applications programs also support software development.

Users can write 8051 code with ASM-51, an absolute macroassembler, that converts the mnemonic assembly-level language into machine-level code. Furthermore, CONV-51, a conversion program that automatically converts 8048 assembly-level source code into its 8051 equivalent, eases upgrading to the new family. Hardware development gets a boost with the ICE-51 in-circuit emulator module, designed to speed system integration for all members of the 8051 family.

Starting with an ICE-51 emulator, a designer can begin to debug his code even before all the prototype hardware has been assembled. Then, as prototype hardware is assembled, the Intellec with ICE-51 can be used to integrate the application code with its hardware and to debug the system. ICE-51 operates on symbolic references, so the designer can refer to program sections with a symbolic name. The ICE module then takes care of all the bookkeeping, making it easy for the user to modify program sections and rearrange the program without worrying about address modifications. Other support includes workshops to be held in several key locations.□

How useful?	Circle No.
Immediate design application	541
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Not applicable	543

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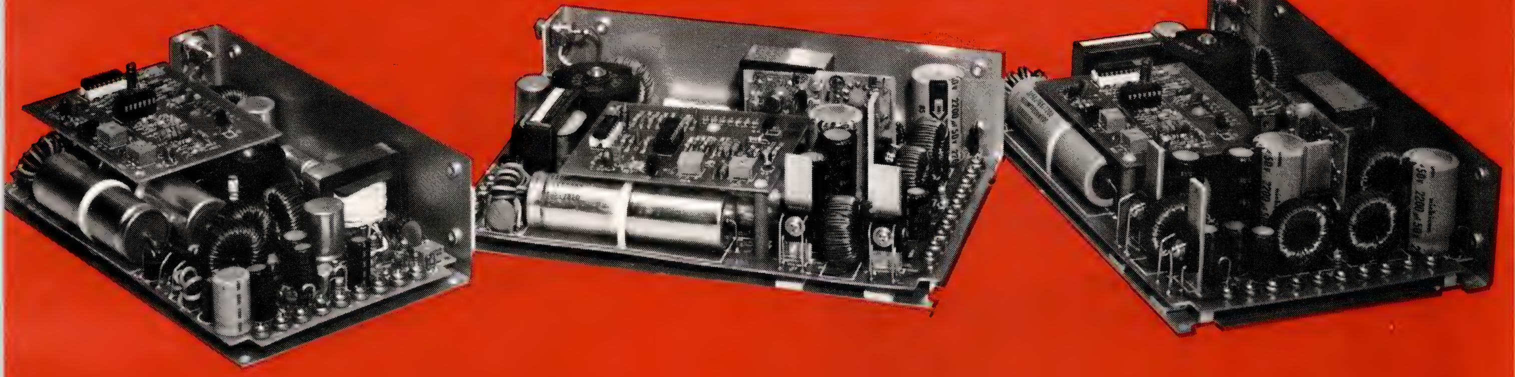

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	ESM-100-5002	5V@10A	15V@3A	15V@3A	5V@2A	24V@2A	100W
Customized Models	ESM-100-xxxx	*@10A	*@3A	*@3A	*@2A	*@2A	100W

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	ESM-200-5002	5V@20A	15V@4A	15V@4A	5V@2A	24V@4A	200W
Customized Models	ESM-200-xxxx	*@20A	*@4A	*@4A	*@2A	*@4A	200W

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	Model	Output 1	Output 2	Output 3	Output 4	Output 5	Max. Cont. Output Power
Standard Models	ESM-300-5001	5V@30A	12V@6A	12V@6A	5V@4A	24V@4A	300W
	ESM-300-5002	5V@30A	15V@6A	15V@6A	5V@4A	24V@4A	300W
Customized Models	ESM-300-xxxx	*@30A	*@6A	*@6A	*@4A	*@4A	300W

* User specified Consult factory or local sales office Minimum 250 units

Note 1: Maximum specified current cannot be drawn from all outputs simultaneously. At no time should the average current exceed the maximum continuous output power. Above this point, output voltages and currents will be automatically reduced on all outputs. **Note 2:** Output 1 must be loaded to 15% of total output power to maintain proper regulation of other outputs (Supply will not be damaged by no-load condition on Output 1) **Note 3:** On ESM-200 and ESM-300 models, all five outputs are isolated. On ESM-100 models outputs 4 and 5 have a common return. All other outputs are isolated

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Efficiency. 65 to 80% typical.

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Remote or Local Sensing. Provision included for improved overall regulation.

Overload and Short Circuit Protection. Solid state short circuit protection. Automatic electronic current limiting circuit limits output current to a preset value, thereby providing protection for the load as well as the supply. Units cannot be damaged by prolonged short circuits.

Overshoot. No voltage spikes on turn-on, turn-off or power failure.

Overvoltage Protection. Built in on primary output.

Energy Storage Time. The output voltage will remain within regulation for a minimum of 16 milliseconds after loss of AC input power (from nominal line voltage).

Polarity. May be either positive, negative or floating up to 300 volts DC.

Soft Start. Provides input current limiting at turn-on.

Long Term Stability. 0.1% for 8 hours after 20 minute warm-up.

Ambient Operating Temperature. Continuous duty from 0°C to 71°C. Full rating from 0°C to 50°C, derate linearly to 50% of rating at 71°C.

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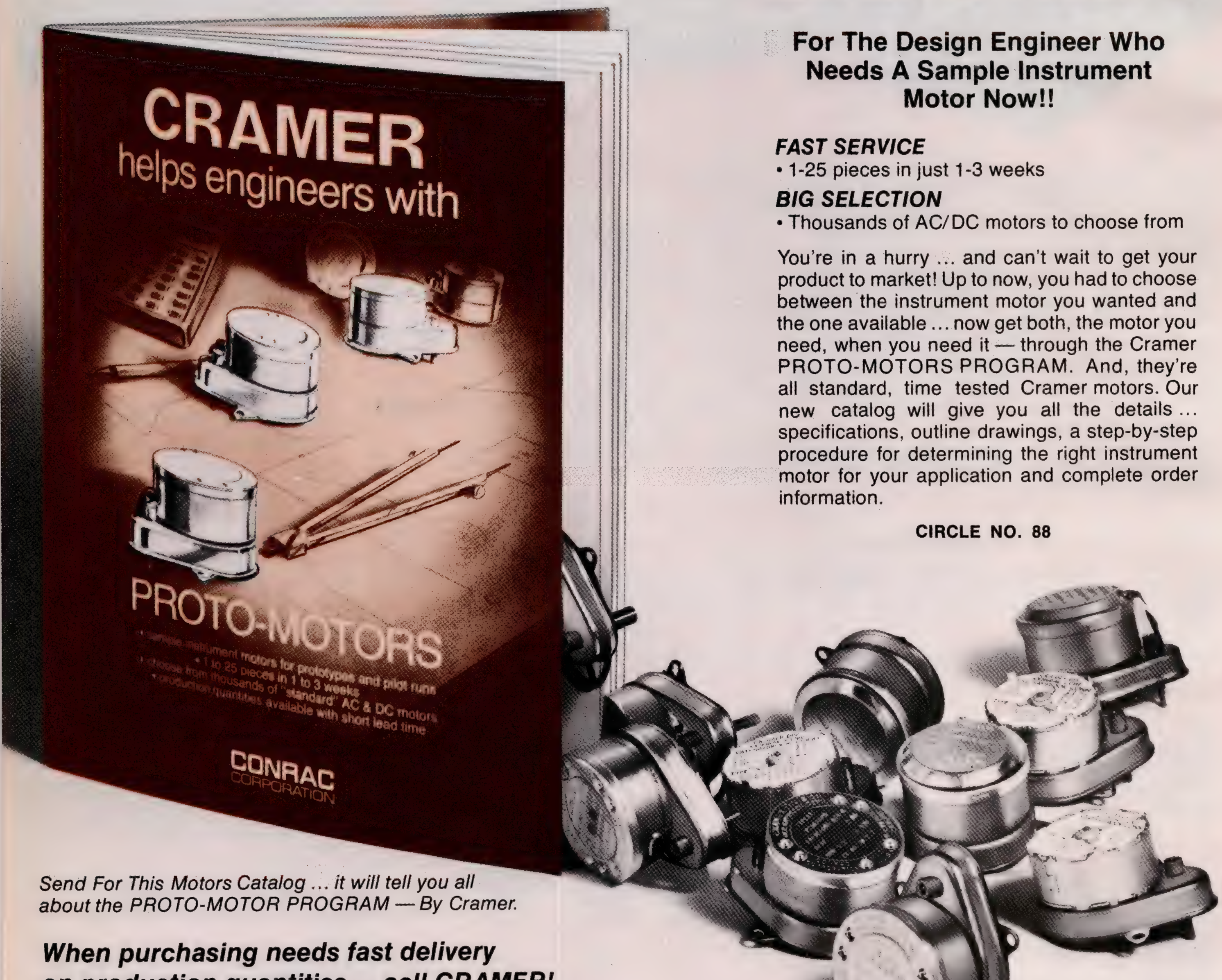
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The three parts of a multichannel, fiber-optic system come from three manufacturers, but operate at their best together. Crimp-on diode connectors join the new semiconductors to plastic-fiber cables.

Three technologies forge a better fiber-optic link

Advances in component technologies converge from three directions to create a fiber-optic link that outclasses traditional wire and cable in size, weight and noise immunity and approaches straight-wire connections in cost and design flexibility. Nowhere is the strength of joined forces more apparent than in the High Density Connector Interface; it combines active semiconductor elements from Honeywell Spectronics, plastic fibers from DuPont and diode connectors from ITT Cannon Electric.

Jointly announced by the three companies, the HDC Interface facilitates circuit-card-to-circuit-card and cabinet-to-cabinet transmissions at data rates up to 30 Mbits/s and at distances up to 30 m. The resulting data link will handle digital and analog transmissions for computer peripherals, instruments, and industrial process controls.

With the HDC Interface, a simple—and repeatable—plug-in operation mates and unmates the fiber ends to semiconductor emitters and receivers in TO-18-style packages (Fig. 1). Like conventional pigtailed semiconductors, the HDC Interface allows the engineer to position emitters and detectors anywhere on a circuit board. But in conventional pigtails, the fiber end is glued to the diode; therefore, the junctions are fragile and frequently break.

Some manufacturers have attempted to replace pigtails with a butt-mating scheme, in which the semiconductor elements are packaged in the connector shell. However, the HDC Interface is superior to this option also, in several respects.

In the butt-mating scheme, the connector housing is not the best size for high-density multipin packaging and the prepackaged semiconductors are often incompatible with other kinds of fiber-optic connections. In the HDC Interface, the semiconductor elements can be mounted by themselves on a PC board, and they mate readily with Cannon's low-

Gary M. Null, Assistant Vice President
Spectronics Div. of Honeywell, Inc.
830 E. Arapaho Rd., Richardson, TX 75081

Julius Uradnisheck PhD., Marketing Specialist
DuPont Co.,
Wilmington, DE 19898

Ronald L. McCartney, Product Manager
Fiber Optics Circular Products Unit
ITT Cannon Electric
666 E. Dyer Rd., Santa Ana, CA 92702

profile diode connector. The elements of the HDC Interface are compatible with other types of components, and can be used separately as well as together. For example, Cannon's high-density multipin connectors accept a variety of fiber-pigtail ends and wire gauges, in addition to the DuPont plastic fibers. However, each element has been developed to provide its optimum value as part of the HDC Interface.

Emitters and detectors

In conjunction with the HDC Interface, for example, Honeywell Spectronics is introducing a new series of fiber-optic detectors: The SD-4323 (a medium-speed detector-preamplifier), the SD-4478 (a high sensitivity p-i-n photodiode), the SD-4324 (an integrated Schmitt-trigger-detector) and the SD-4352, a new version of the popular 3352 detector. All devices are available in hermetically-sealed TO-46 cans with glass windows at the top, or with low-cost clear plastic caps which combine with TO-18 headers. All devices employ Spectronics' popular "Sweet Spot" microlens technology.

The SD-4323 detector is integrated on the same chip with a transistor preamplifier. The responsivity of the entire device is approximately 30 to 40 μA/μW for receiving a wavelength of 820-nm from a 100-μm core cable and driving a 5-V, 200-Ω load. The device is fast enough to produce a 2-MHz analog or 1-Mbit/s digital output. The dark current is less than 1 μA at 5.5 V, so on and off states are easy to distinguish, and the device interfaces readily with TTL or comparator circuitry.

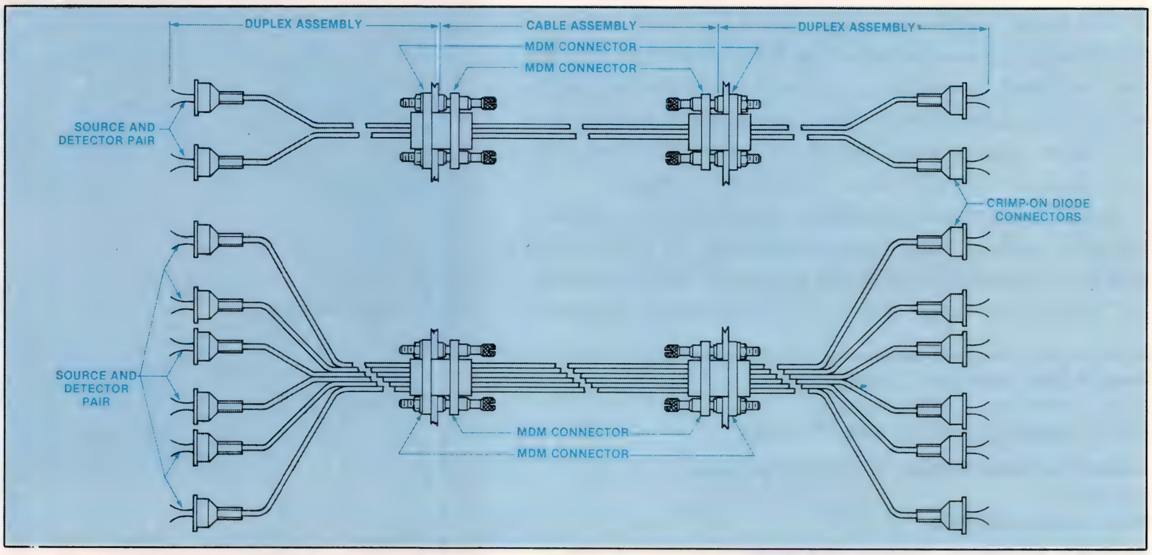
The high-speed SD-4478 photodiode has a responsivity of 0.45 μA/μW at 820 nm, and a peak responsivity of approximately 0.5 μA/μW at 907 nm. Because its rise time is less than 5 ns with a 15-V bias voltage, it supports 50-Mbit/s transmission. The rise time can be further shortened by increasing the bias voltage. With 50-V bias, for example T_r drops to 2 to 3 ns. Even with 5-V bias and reduced responsivity, the device is fast enough to accommodate 2 and 3-Mbit transmissions.

The SD-4324 is an integrated detector amplifier and Schmitt trigger. If offers 2-μW sensitivity at 820 nm, a built-in threshold detector buffer and comparator, and a TTL or CMOS-compatible output pulse. The device carries just three-pins (power, data output and ground) and provides a 0 to 15-V output, regulated by the supply voltage of 4.5 to 16 V. The integrated package simplifies low-speed (100-kbit/s) data transmission—and cuts the cost.

The SE-4352 Sweet Spot LED puts out 0.7 mW of power at 820 nm with a 100-mA drive and a 12 ns rise time. Together, these detector packages create many options for varying the distance and speed of transmissions through large-core plastic fibers, such as Dupont's Pifax P-140 and PIR-140. The SE-4323 accepts transmission up to 1 Mbit/s (Fig. 2, top) and over a distance of 5 m (with the P-140 fibers) or 15 m (with the PIR-140). The SD-4478 transmits data at a maximum rate of 30 Mbit/s and over a top distance of 15 m (with P-140 fibers) or 30 m (with PIR-140). The SD-4324 Schmitt detector is the slowest, at 100 kbits/s, but can extend the transmission distance up to 30 m with PIR-140 fibers (up to 10 m with P-140).

The Sweet Spot connects to the fiber

In Spectronics' "Sweet Spot" technology (Fig. 3, top) a microlens (a small glass bead glued to the surface



1. The HDC Interface includes Spectronics' light sources and detectors, Cannon's crimp-on diode connectors, and DuPont's Pifax optical fibers. Cannon's microminiature high-density MDM connectors can take both electrical and fiber-optic lines, for multichannel cabinet-to-cabinet transmissions up to 40 m.

of a LED at its aperture) focuses the light output of the LED onto the window surface of an open TO-46 can that houses the diode. The beam of light is approximately 300 μm in diameter, several times larger in diameter than many optical fibers. Thus, alignment tolerances between the fiber ends and the LED can be somewhat relaxed, for effective coupling will occur so long as the fiber end is within the circumference of the Sweet Spot.

The DuPont fibers developed for the HDC Interface have 370-μm cores (NA-0.53) that couple well with the 300-μm diameter of the Sweet Spot. The Pifax P-140 Type B and PIR-140 Type B cables are manufactured by DuPont from a strong but flexible acrylic polymer, reinforced with DuPont's Kevlar aramid fibers. The plastic fibers are able to withstand tensile stresses up to 25 kg, while maintaining the flexibility of a 1 mm bend radius. For short-haul transmissions, the attenuation of the fibers is much less than that of a communications-grade fiber with a 50-μm core.

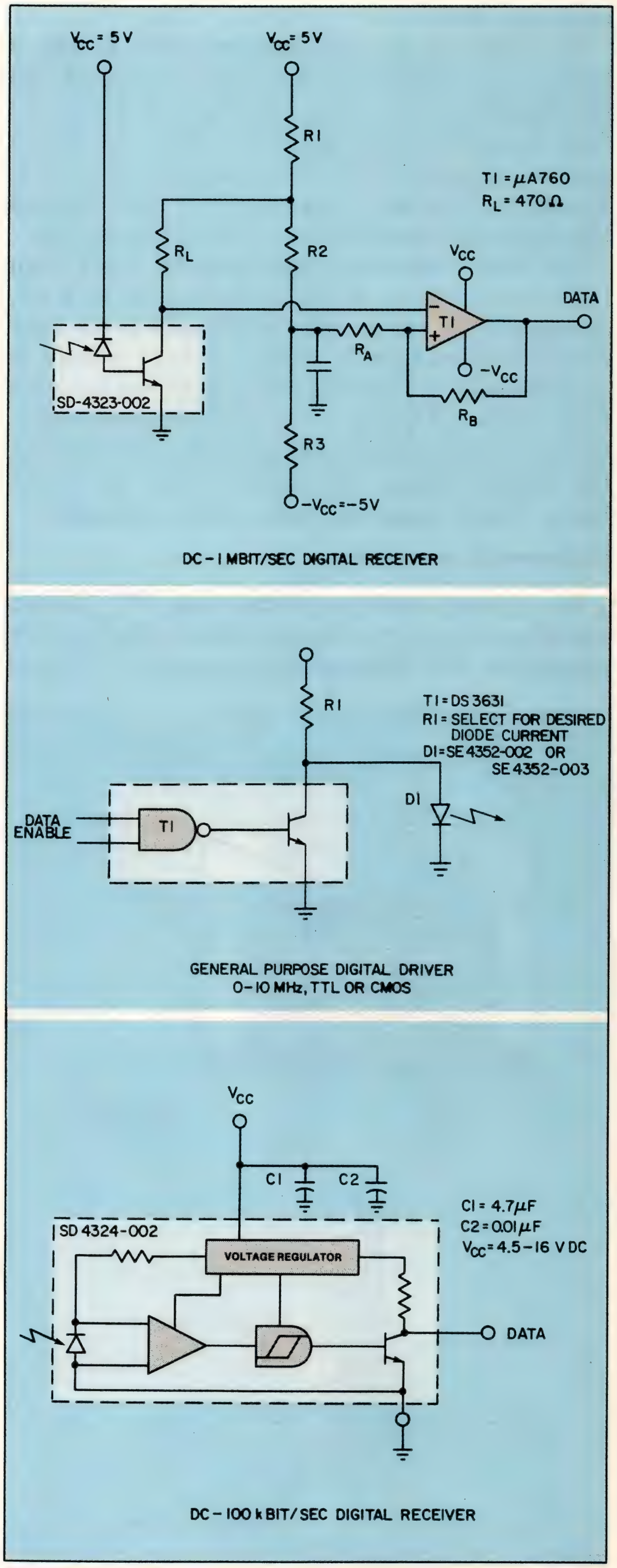
DuPont feels that the specifications for cable attenuation need close examination. On the specification sheet, the PIR-140 has a typical attenuation coefficient of 500 dB/km at 820 nm, and communications-grade cable has an attenuation of 3 dB/km. For distances up to about 30 m, however, the PIR-140 provides up to 10 times more radiated power through the fiber than the communications-grade fiber (see Fig. 4). In other words, the large-core DuPont fiber facilitates short-haul transmissions better than the small-core communications-grade fiber.

DuPont developed PIR-140 Type B and P-140 Type B cables with outer jacket diameters of 1250 μm, which fits well within the tight 0.050-in. pin spacings on Cannon's high-density microminiature connectors.

DuPont also manufactures hard plastic-clad silica-core cables with attenuations of less than 30 dB/km at 820 nm. However, all f-type plastic cables have several advantages compared to silica fibers. Plastic cables are more flexible and therefore more adaptable to field terminations; they are compatible with the crimp-on Cannon diode connectors; and they always require less labor-intensive polishing than silica.

Stainless-steel diode connectors

The first production units of the Cannon diode connector will be made of a highly compliant #305 stainless steel (0.005 to 0.010 in. thick), which positions the fiber end without specialized tooling and still maintains enough dimensional stability to sit firmly and snugly around the cap of a TO-18 package—like the packages that house Spectronics semi-



2. A 1-Mbit/s digital receiver (top) incorporates the SD-4323 integrated detector-preamp. The SD-4352 Sweet Spot LED readily accommodates digital transmissions up to 10 MHz with few components (middle). The SD-4324 integrated Schmitt-detector-trigger simplifies the design of low-speed data receivers (bottom).

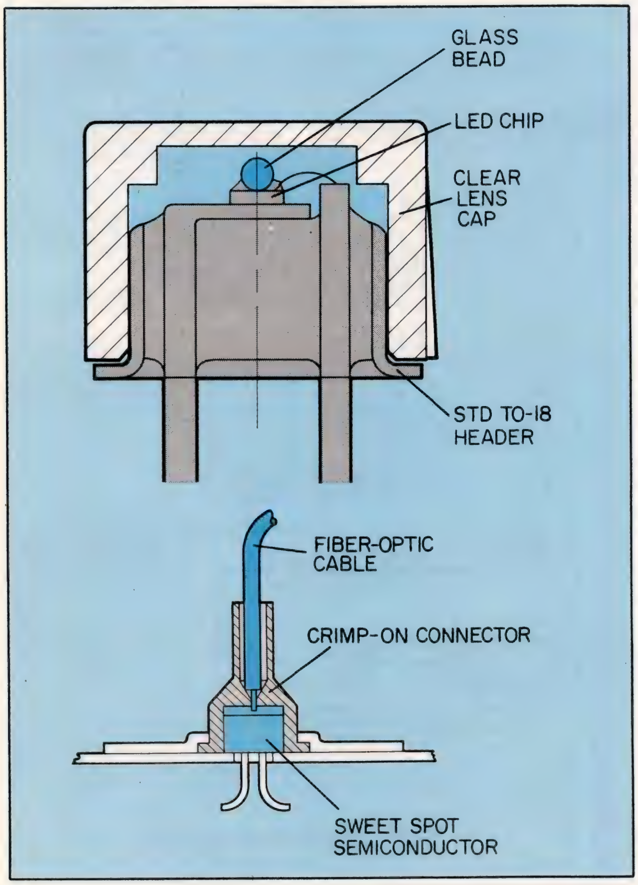
conductor devices.

As shown in the cross-sectional view in Fig. 3 bottom, the stripped end of a fiber is inserted into the alignment sleeve and pushed in until it emerges from the narrow end of the ferrule. When the sleeves are wedged together, the fiber jacket is held in place. The narrow channel at the end of the ferrule aligns the fiber with the aperture of the LED emitter.

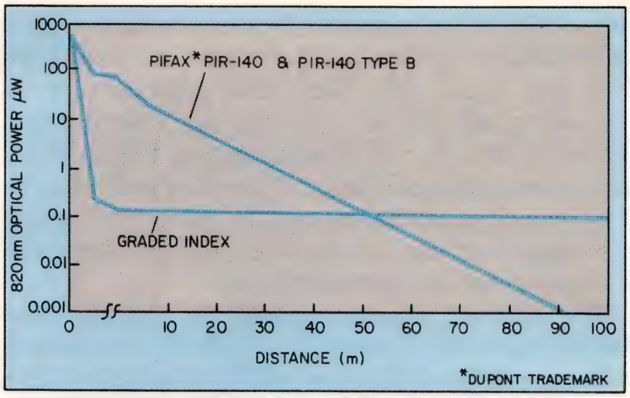
The diode connector keeps coupling losses from LED-to-fiber down to approximately 2 to 3 dB, operates from −40 to +60 C and exerts a connector cable retention force in excess of three pounds. It creates the equivalent of a fiber pigtail; but the since fiber end is not glued to the semiconductor and, it will not cause problems with loose fiber strands when the semiconductors are soldered into the circuit board. Diode connectors are simply unplugged.

High-density connections

For cabinet-to-cabinet connections, ITT Cannon has adapted its microminiature series of high density connectors. The MDM series subminiature "D"-type connectors represent the first of Cannon's multipin connectors to be adapted for fiber-optic use (others will be introduced during 1980).



3. A microlens on the surface of the diodes focuses light on the plastic window of Spectronics emitters and detectors (top). Cannon's crimp-on diode connector aligns DuPont's plastic-core fiber ends toward the 300-μm diameter of the "Sweet Spot" and fits snugly over the TO-18-style plastic case of the semiconductor device (bottom).



4. For short distances, more optical power is transmitted by Pifax large-core fiber than by small-diameter communications-grade fibers.

The MDM series comes in seven sizes of rugged aluminum shells, offers a maximum of 51 contact points (and a minimum of 9), and can interconnect all 51 channels in one operation. The contacts are on 0.050-in. centers. The connector shell provides EMI/RFI shielding better than 40 dB up to 100 MHz. A silicone-elastomer base protects the connector from moisture. When the rear of the connector shell is sealed with epoxy, the connector conforms to the ten-day humidity specification of MIL-STD-202, Method B.

The 450-μm inner sleeve of the receptacle readily accepts DuPont's P-140 and PIR-140 fibers, which have a cladding diameter of just 400 μm. The receptacle is inserted into the connector body and sealed with epoxy; the connector plug and receptacle lock together with a jackscrew arrangement.

The MDM connector is rated for an optical coupling loss of 3 dB typical (6 dB maximum). The connector-to-cable retention force is better than five pounds.

The connector may also be used with electrical lines, employing a Twist-Pin contact system. The pin portion of tinned flexible 24-gauge wire is recessed in the connector body (which is made of diallyl phthelate). The metal sleeve of the contact receptacle is then inserted into the connector shell over the pin. A tight mechanical connection results between the contact receptacle and the connector body.

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Immediate design application	544
Within the next year	545
Not applicable	546

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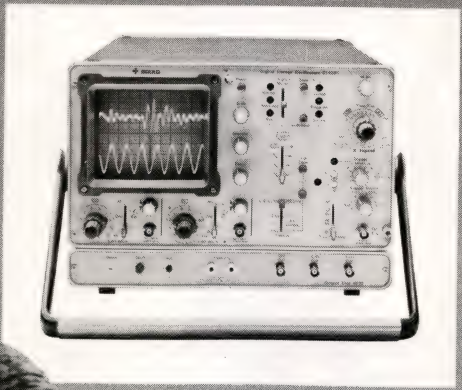

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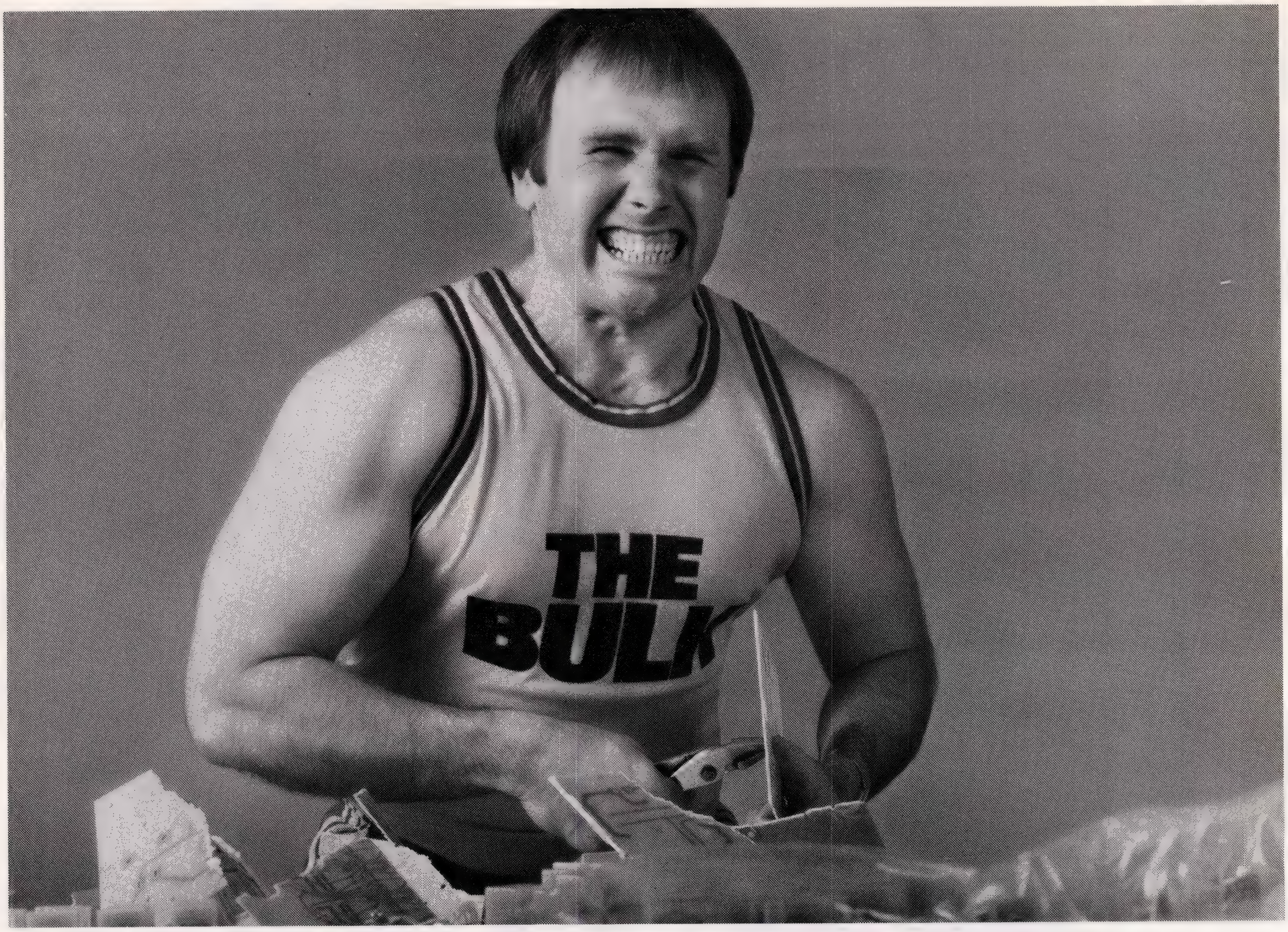

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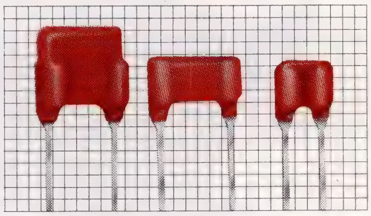

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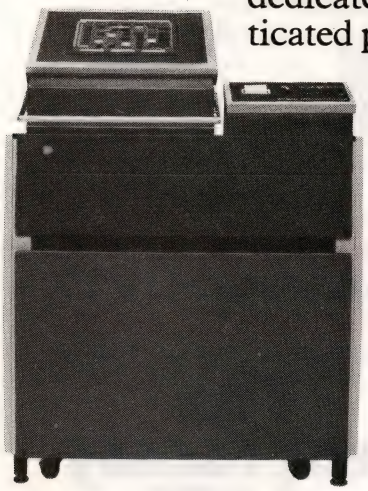

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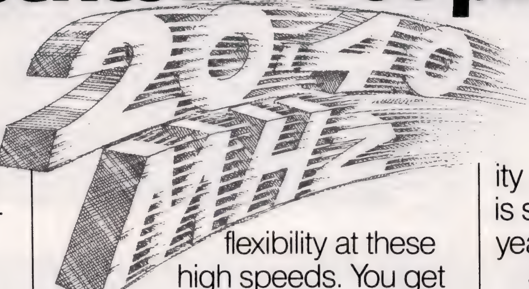

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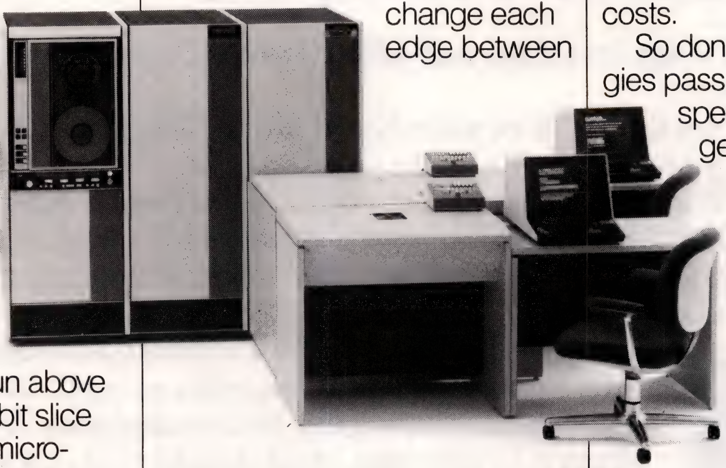

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CIRCLE NO. 153

The MC6801 system on a chip (Aug. 2, 1979, p. 76) has eight operating modes (Feb. 15, 1980, p. 118) and a powerful instruction set (Feb. 15, p. 127). It also features a complexity-reducing timer/counter.

Timer/counter schedules µC interrupts—simply

With a potent instruction set and multiple operating modes, the MC6801 provides a powerful set of design capabilities. But with the latest levels of integration comes a lot more. In addition to on-line parallel I/O and RAM and ROM and a serial-I/O port, the processor includes a 16-bit programmable timer/counter. As a result, the MC6801 provides a complete microcomputer system that, along with the hardware features already mentioned, includes multiple prioritized and self-vectored interrupts that are both level and edge-sensitive.

Many recently introduced µCs include at least one programmable timer/counter. However, the 6801 timer/counter can be operated in three different ways. In addition, the timer subsystem can do the following things simultaneously:

- Measure the duration of input pulses with respect to the system clock (E)
- Generate variable-length output pulses
- Generate a timer-overflow status flag
- Provide a clock for the serial-communications interface included on the chip.

As a result, three separate, individually maskable interrupts can be generated: input capture, output compare and timer overflow, in that order.

Countless capabilities

Within the MC6801, the timer/counter subsection consists of a free-running 16-bit counter, a control/status register for the timer, a 16-bit input-capture register, a 16-bit output-compare register and an 8-bit counter LSB buffer.

The counter, which increments with each enable (E) cycle, can be read from counter register COUNTR at locations $9 (for the MSB) and $A (for the LSB). Since it never stops counting except during 6801 reset, when it gets cleared, COUNTR can keep track of passing time according to the stability and accuracy of the system oscillator.

In addition, the register's normal count can be altered only when the processor writes to its first byte (this always presets the counter momentarily to value $FFF8).

To read the counter contents, the processor must first read register $9, which brings the counter MSB into the processor while simultaneously latching the counter LSB to register $A. (As explained in the previous MC6801 articles, the processor uses memory-mapped I/O, and reserves internal registers —RAM locations $8 through $E—for timer/counter use). The LSB thus always represents the contents of the counter during the most recent $9 read request.

For example, reading register $9 when the counter happens to be at $A3FD, followed by a $A read operation, will always deliver $A3FD; without the buffering of the latches, though, the $9 read would bring in $A3 data, but the $A read might accept $FE, $00, or other values, depending on the instruction sequence followed. Hence, the result could be interpreted as $A300 when $A400 would be much more appropriate.

The timer features an input capture mode that records the exact time of external logic transitions and optionally notifies the processor. A timer comparison helps the processor generate pulse widths by accurately manipulating the state of an output pin and/or influencing the flow of program execution. In addition, timer-overflow recognition allows the processor to keep track of time periods longer than 65,536 clock cycles, and serves as a dependable program checkpoint in systems having irregular timing functions.

The MC6801 does program response and control of the timer functions with software polling or interrupt drive. The timer control/status register (TCSR) allows programmable "on-the-fly" control and monitoring of all timer operations. Individual

Clint Bauer, Staff Engineer
Automotive Systems Engineering
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timer-flag bits are included to enhance software polling, and enable bits to allow timer interrupt control.

At location $8, the TCSR includes eight bits, which are assigned to control the various operations and interrupt masks. All bits in the register are cleared when the processor is reset, and are basically divided into two groups—bits 0 to 4 are control bits and can be written or read, while bits 5, 6 and 7 are status bits and can only be read by the processor. The table defines all the functions of each bit.

Instructions simplify timing

Accessing the timer registers is a good opportunity to gauge the usefulness of the 6801's new instructions. For example, LDD $9 (Load Double Accumulator from $9 and $A) automatically reads the COUNTR registers in the correct order, requiring just two bytes of code and four machine cycles for execution. ADDD $9, SUBD $9, LDX $9, LDS $9 and CPX $9 access the counter just as efficiently. Normal MC6800 operation codes include LDX, LDS and CPX; however, the CPX command of the MC6800 only sets certain status bits, while the same command on the 6801 delivers the full status of the 16-bit comparison operation relative to other values.

When the COUNTR register regularly overflows to $0000 from $FFFF (every 65.536 ms for a 1-MHz E frequency), the timer-overflow flag (TOF) gets set and can cause the processor to interrupt if the enable-timer overflow-interrupt bit (ETOI) has been set and the processor I bit is clear. Both of these TCSR bits are readable, and the ETOI bit in the TCSR can be written to at location $8.

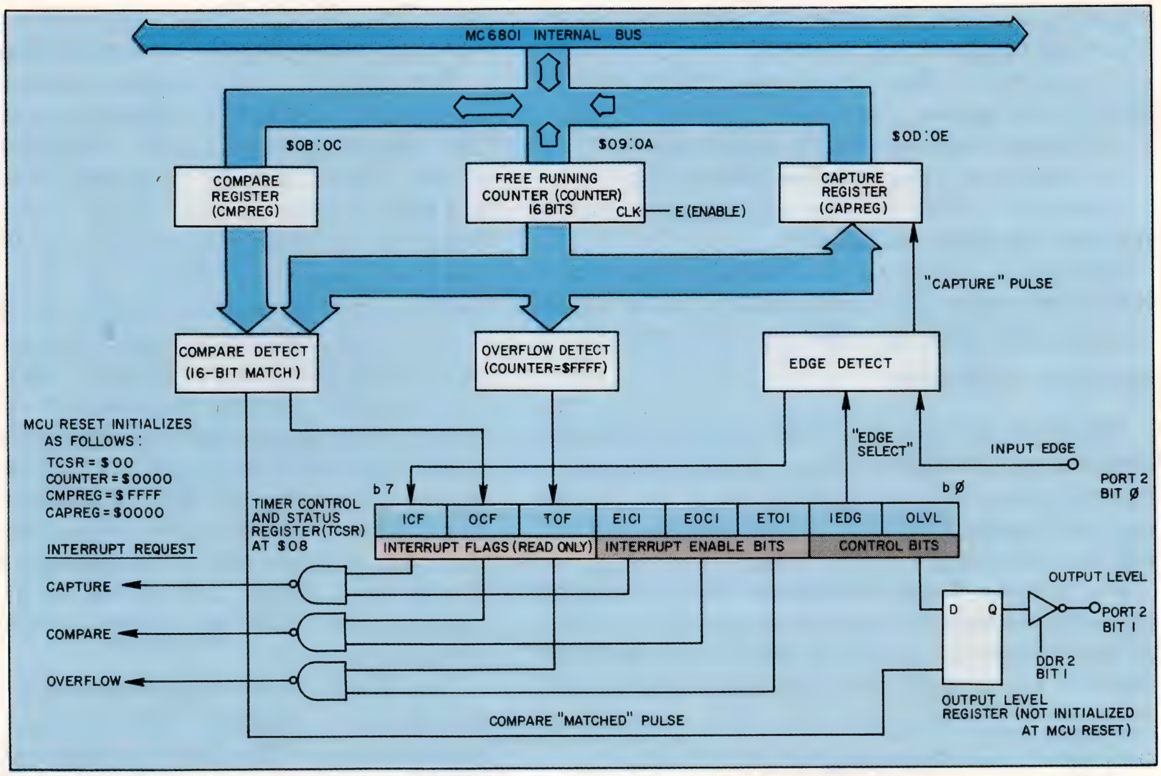
Programs that take advantage of this feature either poll TOF and branch when true, or allow automatic interrupt service by setting ETOI. Where overflow service is unnecessary, the program can allow ETOI to remain clear so that TOF is ignored; TOF will soon become and remain high, but will not influence program execution.

For long time-period counting, a 16-bit timer will overflow. However, maintaining overflow status, as in the program of Fig. 2, will obtain greater timer ranges. Bear in mind that in some systems, even this simple timer-overflow service produces software overhead.

Comparisons can happen

Other systems can take advantage of the timer-overflow capability to provide other functions—for example, pulse widths can be controlled dynamically and easily in real time when timer-overflow service is used to alter calculations by a small factor each time through. Timer-overflow service can also handle functions such as switch debouncing, which otherwise would have required extra timing loops.

The timer/counter subsystem's output-compare



1. The timer subsystem of the MC6801 microcomputer uses one free-running 16-bit counter and can provide three simultaneous timing functions to generate interrupts: input capture, output compare and timer overflow.

```
PAGE 001      T3      SA:O

00010 00001                        *OVERFLOW SERVICE ROUTINE UPDATES TIME CNT.
00020 00002                        *TIME5, TIME4, TIME3:  CONSECUTIVE RAM BYTES.
00030 00003A  0080                         ORG     $80        RAM AT $0080
00040 00004A  0080     0001    A   TIME5   RMB     1
00050 00005A  0081     0001    A   TIME4   RMB     1
00060 00006A  0082     0001    A   TIME3   RMB     1
00070 00007A  3000                         ORG     $3000
00080 00008A                       * (LDD TCSR READS  $8,  THEN $9. $9=TIMER MSB)
00090 00009A           0008    A   TCSR    EQU     $8         TCSR AT ADDRESS $8
00100 00010A  3000 DC  08      A   TIMOVF  LDD     TCSR       CLEARS TOF BIT
00110 00011A  3002 7C  0082    A           INC     TIME3
00120 00012A  3005 26  06 300D             BNE     OUT        NO TIME3 OVERFLOW
00130 00013                        *NOW INCREMENT 16 BIT TIME5, TIME4
00140 00014A  3007 DC  80      A           LDD     TIME5      TIME5, TIME4 TO D
00150 00015                        *READING DDR1, DDR2(AT  $0, $1) ALWAYS BRINGS
00160 00016                        *$FFFF DATA TO PROCESSOR ALV.  SUBD DDR1
00170 00017                        *THEREFORE SUBTRACTS $FFFF FROM D.
00180 00018                        *ADDD #$0001 ALSO WORKS AT COST OF 1 BYTE.
00190 00019            0000    A   DDR1    EQU     $0         DDR1 AT ADDRESS $0
00200 00020A  3009 93  00      A           SUBD    DDR1       INCREMENT D ACC.
00210 00021A  300B DD  80      A           STD     TIME5
00220 00022A  300D 3B              OUT     RTI
00230 00023                        *24 BIT TIME5, TIME4, TIME3 NOW INCREMENTED.
```

2. When monitoring the status of the overflow-signal flag, this program uses an interrupt handler to save polling time and bytes. With an MC6801 using a 4-MHz crystal or input signal, TIMOVF is entered every 65,536 μs, and TIME5 overflows every 12 days, 17 h, 25 m, 11.625 s.

register (CMPREG) can be used to help generate pretimed output-pin transitions and/or pretimed interrupts. When port pin P_{21} of the MC6801 serves as an output, it cannot be directly written to. Instead, it is exclusively controlled by the timer's output-compare circuitry. Each time the free-running counter matches the value held in CMPREG (locations $B and $C), a pulse is generated to set P_{21} to the state of output-level bit OLVL in the TCSR.

The processor can read and write both CMPREG and OLVL, which means accurately timed waveforms can be created at P_{21} with relatively little software overhead. For example, a program might refer to present time by reading COUNTR, then calculate that P_{21} should fall from its present high state at a future time, N. Writing the 16-bit value N to CMPREG and then clearing OLVL assure that the level on P_{21} will fall at the desired time, even without further programming attention. Leaving OLVL set would allow the compare to occur, but would also transfer a high signal at time N to P_{21}, inhibiting the falling transition.

Timed interrupts are initiated through the use of the output-compare flag (OCF) of register TCSR. Set by any CMPREG match, the flag serves as both timer compare status and interrupt flag bit. In addition, an enable-output compare register (EOCI) bit in TCSR permits the timed interrupt request called for by OCF. A program that leaves EOCI clear will allow the processor to ignore timer comparisons by inhibiting the output-compare interrupt. If totally ignored, OCF assumes a permanent high state because continual timer comparisons occur without intervening program response. Timed output transition control is enabled when bit 1 of the processor's data direction register 2 (DDR2) is set, while timer-compare interrupts are allowed by setting the TCSR's EOCI bit.

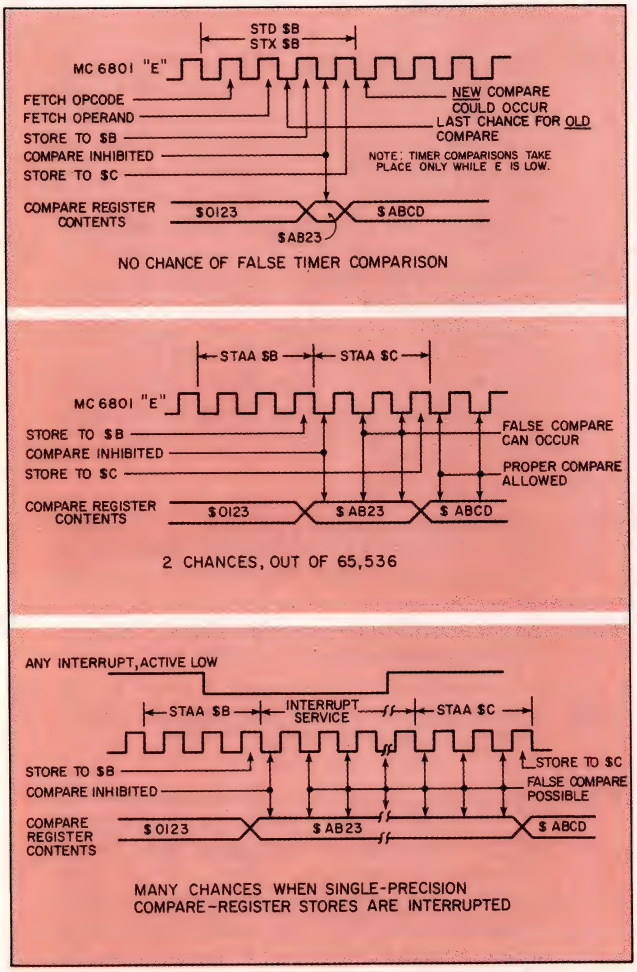
Timer C/S register functions

7	6	5	4	3	2	1	0
ICF	OCF	TOF	EICI	EOCI	ETOI	IEDG	OLVL

ICF	**Input-capture flag:** A status bit set by a valid transition at the timer-input pin (bit 0 of Port 2). A valid transition is defined by the input edge (IEDG) bit of the C/S register. The ICF bit can be cleared by a read of the C/S register, followed by a CPU read of the input-capture register's high byte (location 000D).
OCF	**Output-compare flag:** A status bit set when the contents of the output-compare register match that of the 16-bit free-running counter. The OCF can be cleared by a CPU read of the C/S register followed by a write to either the high or low byte (locations 000B or 000C) of the output-compare register.
TOF	**Timer-overflow flag:** A status bit set during E period of the clock following the master clock cycle that advances the free-running counter to value FFFF. The TOF bit can be cleared by a CPU read of the C/S register followed by a CPU read of the most significant byte of the timer counter (which is at location 0009).
EICI	**Enable-input-capture interrupt:** An interrupt mask bit that, when cleared, prevents an interrupt from occurring once the ICF is set.
EOCI	**Enable-output-compare interrupt:** Similar to EICI but responds to the OCF bit.
ETOI	**Enable-timer-overflow interrupt:** Similar to EICI but responds to the TOF bit.
IEDG	**Input-edge bit:** Selects which transition edge of the timer input signal will generate an input-capture pulse. This pulse sets the ICF bit, and transfers the contents of the 16-bit counter into the input-capture register. If the IEDG bit is cleared, the falling edge of an input does the triggering; if the bit is set, the rising edge of the input does the triggering.
OLVL	**Output-level bit:** Defines the logic level that the timer will output at bit 1 or Port 2 when the next timer-compare pulse appears. Such a compare pulse is generated when the value of the output-compare register is the same as the counter. (The data-direction register of Port 2 must define bit 1 or Port 2 as an output for the timer function to operate.)

Of the MC6801's control-register set, CMPREG is the only one that behaves like a read/write location (except that reset initializes the register to $FFFF). When P_{21} is configured as an input and the compare interrupt disabled, addresses $B and $C could be used as spare RAM locations. More important, however, the processor's ability to read comparison timing information can be useful in interrupt-intensive applications.

In addition, transitions occurring at processor pin P_{20} could trigger a timer capture and a processor-interrupt request, which occur when the transition matches that specified by the input-edge (IEDG) bit of the TCSR (positive edges for IEDG = 1, and negative edges for IEDG = 0). Operating as an input for these functions, P_{20} allows asynchronous external event times to be recorded (captured) and brought to the attention of the processor by interrupt request.



3. Double-store instructions are the most efficient way to access the timer registers when using the compare register. In these examples, the compare register is changed from $0123 to $ABCD.

The same triggering occurs when P_{20} operates as an output; toggling the pin allows the processor to mark time through timer capture. Indeed, this scheme can help the processor interrupt its own program execution. On the other hand, when these capture functions are not needed, the processor can use P_{20} as normal I/O by leaving the capture interrupt disabled.

Each input transition on P_{20} allowed by the IEDG will set the input-capture flag (ICF) of the TCSR while simultaneously causing the current timer contents to be loaded into the capture register (CAPREG), readable at $D and $E. In addition, if the enable input-capture-interrupt (EICI) bit has been set by the processor, an interrupt is requested; no interrupt is requested if the bit is cleared. Disabling the interrupt will not prevent the external transition from being sensed, but choosing to ignore the transitions will cause captures to be triggered repeatedly without intervening program responses—thus, the ICF bit will become permanently set.

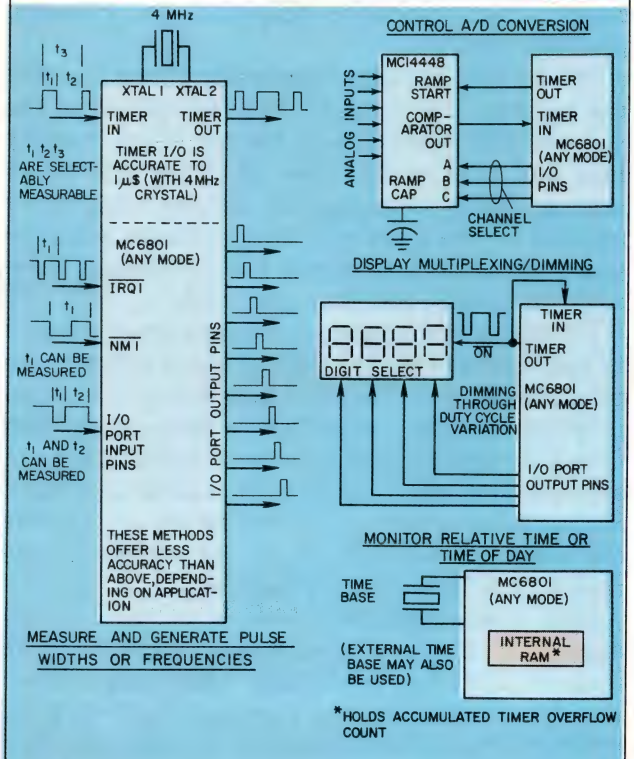
Double-precision commands ease comparisons

As the timing diagrams in Fig. 3 show, the best way to take advantage of the output-compare function is to use the 6801's double-precision (double byte) storage instructions. For example, the Store Double Accumulator (STD) and Store X (STX) instructions absolutely prevent the possibility of false comparisons. Writing to the 8-bit halves of CMPREG in consecutive clock cycles, they limit to one cycle the time during which nonvalid comparisons might occur. Moreover, to prevent false comparison during that time, the 6801 automatically inhibits output compares for one cycle following any write to register $B. This also eliminates a false compare-interrupt that might otherwise occur in the middle of compare-register updates.

Double-precision instructions prove just as handy for capturing inputs and thus preventing incorrect interpretation of timer data. If single-precision commands were used, input captures occurring between readings of the high and low bytes of CAPREG could cause unmatched data to be transferred to the processor accumulators. Instead, delaying capture behavior during the cycle following a processor read of register $D eliminates the problem since both $D and $E are read on consecutive clock cycles. Conse-

```
PAGE  001     T5      SA:0

00010 00001                          *INITIALIZE TIMER FUNCTIONS AND INTERRUPTS
00020 00002              00001  A    DDR2   EQU    $1        DDR2 AT ADDRESS $1
00030 00003              00008  A    TCSR   EQU    $8        TCSR AT ADDRESS $8
00040 00004              0009   A    COUNTR EQU    $9        COUNTR AT ADDR. $9
00050 00005              000B   A    CMPREG EQU    $B        CMPREG AT ADDR. $B
00060 00006              000D   A    CAPREG EQU    $D        CAPREG AT ADDR. $D
00070 00007A  3000                          ORG    $3000
00080 00008                          *THE MC6801 IS RESPONDING TO AN ACTUAL
00090 00009                          *HARDWARE RESET. BIT I IS SET AND
00100 00010                          *REGISTER TCSR IS ZEROED.
00110 00011A  3000 8E 00FF      A    RESTRT LDS    #$00FF    STACK AT TOP OF RAM
00120 00012                          *A LOW SIGNAL AT P21(TIMER-OUT) IS DESIRED.
00130 00013                          *ESTABLISH FIRST THE INTERNAL P21 DATA
00140 00014                          *REGISTER TO A LOGIC 0 STATE. THEN, MAKE
00150 00015                          *P21 AN OUTPUT BY WRITING TO DDR2.
00160 00016A  3003 CC 0007      A           LDD    #$0007    ADD this to countr
00170 00017A  3006 D3 09        A           ADDD   COUNTR
00180 00018A  3008 DD 0B        A           STD    CMPREG    GIVES QUICK COMPARE
00190 00019A  300A CC 021E      A           LDD    #$021E    A=$02. B=$1E
00200 00020                          *THE P21 DATA REGISTER IS BY NOW A ZERO.
00210 00021                          *IMPORTANT NOTE: BIT I IS SET, PREVENTING
00220 00022                          *AN INTERRUPT JUST BEFORE "STD CMPREG."
00230 00023                          *FOR SYSTMES WITH ACTIVE NMI, A SCHEME
00240 00024                          *THAT ADDS GREATER OFFSET AND POLLS OCF
00250 00025                          *UNTIL SET SHOULD BE EMPLOYED.
00260 00026A  300D 97 01        A           STAA   DDR2      P21 AN OUTPUT.
00270 00027                          *INSERT HERE VARIOUS INTITIALIZATIONS,
00280 00028                          *INCLUDING THOSE NEEDED SO CAPTURE
00290 00029                          *INTERRUPT CAN BE HANDLED.
00300 00030A  300F 01                       NOP              INSERT CODE HERE
00310 00031                          *ENABLE ALL TIMER INTERRUPTS. THE PROCESSOR
00320 00032                          *INTERRUPT MASK IS STILL SET, PREVENTING
00330 00033                          *SERVICE OF CAPTURE FLAG THAT MIGHT NOW BE
00340 00034                          *SET. ALSO: SET IEDG, KEEP OLVL CLR.
00350 00035A  3010 D7 08        A           STAB   TCSR      $1E DATA TO TCSR
00360 00036                          *DESIRED CAPTURE IS AT POSITIVE EDGE
00370 00037                          *OF TIMER-IN PIN. IF ICF(CAPTURE FLAG) IS
00380 00038                          *NOW SET, IT WAS PROBABLY CAUSED BY
00390 00039                          *NEGARIVE EDGE. CLEAR ICF SO PROCESSOR CAN
00400 00040                          *IGNORE THIS UNWANTED TRANSITION.
00410 00041A  3012 96 08        A           LDAA   TCSR      ARMS BIT-CLR MECH.
00420 00042A  3014 96 0D        A           LDAA   CAPREG    ICF BIT CLEARED
00430 00043                          *ENABLE PROCESSOR INTERRUPTS
00440 00044A  3016 0E                       CLI              INT. MASK REMOVED
00450 00043                          *FROM THIS POINT ON, CAPTURE INT. OCCURS AT
00460 00046                          *EACH POSITIVE INPUT EDGE, OVERFLOW INT.
00470 00047                          *WHEN COUNTER REACHES $FFFF, AND COMPARE
00480 00048                          *INT. WHEN COUNTER MATCHES VALUE
00490 00049                          * IN COMPARE REGISTER. CAPTURE COULD OCCUR
00500 00050                          *AT ANY TIME, WHEREAS OVERFLOW WILL NOT
00510 00051                          *TAKE PLACE FOR MANY COUNTS BECAUSE THE
00520 00052                          *COUNTER WAS HARDWARE-RESET TO $0000.
00530 00053                          *THE 1ST COMPARE INT. OCCURS AT TIME=$FFFF
00540 00054                          *(THE RESET STATE OF ITS REGISTER), UNLESS
00550 00055                          *PROGRAM EXECUTION CHANGES THIS VALUE.
00560 00056                          *
00570 00057                          *CONTINUE NOW WITH MAIN PROGRAM.
00580 00058A  3017 01                MSIN   NOP
```


4 MHz
XTAL I
XTAL 2
TIMER IN
TIMER OUT
t_3
t_1 t_2
t_1 t_2 t_3 ARE SELECTABLY MEASURABLE
TIMER I/O IS ACCURATE TO 1 µs (WITH 4 MHz CRYSTAL)
MC6801 (ANY MODE)
t_1
IRQ1
NMI
t_1 CAN BE MEASURED
I/O PORT INPUT PINS
t_1 AND t_2 CAN BE MEASURED
I/O PORT OUTPUT PINS
THESE METHODS OFFER LESS ACCURACY THAN ABOVE, DEPENDING ON APPLICATION
MEASURE AND GENERATE PULSE WIDTHS OR FREQUENCIES
CONTROL A/D CONVERSION
MC14448
ANALOG INPUTS
RAMP START
COMPARATOR OUT
RAMP CAP
A
B
C
TIMER OUT
TIMER IN
MC6801 (ANY MODE)
I/O PINS
CHANNEL SELECT
DISPLAY MULTIPLEXING/DIMMING
DIGIT SELECT
ON
TIMER IN
TIMER OUT
MC6801 (ANY MODE)
DIMMING THROUGH DUTY CYCLE VARIATION
I/O PORT OUTPUT PINS
MONITOR RELATIVE TIME OR TIME OF DAY
TIME BASE
(EXTERNAL TIME BASE MAY ALSO BE USED)
MC6801 (ANY MODE)
INTERNAL RAM*
*HOLDS ACCUMULATED TIMER OVERFLOW COUNT

4. To initialize all the registers in the timer subsystem, this detailed program (top) starts with the assumption that power has already been turned on. Typical applications of the timer subsystem (bottom) show some of its many control and signal-generation capabilities.

quently, instructions LDD $D, ADDD $D, SUBD $D, LDX $D and CPX $D will reliably read correct capture times.

Start timing

With the basic capabilities of the timer subsystem in mind, start programming it to perform various functions. There are several ways to start the timer. When the 6801 gets reset, the output-compare register is preset to $FFFF, the 16-bit counter is initialized to $0000, and the TCSR is cleared. As a result, overflow and compare operations are scheduled to occur at a maximized time after execution begins. And the initialization software that is executed directly after an MC6801 reset can enable these two interrupts with the knowledge that the request flags will not be set.

However, since the input capture function, controlled as it is by external hardware, might occur before initialization is completed, the capture interrupt should be enabled only after all things necessary for the desired response have been set up. The program listing in Fig. 4 (top) shows a sample initialization of all timer functions, with some typical applications shown in Fig. 4 (bottom).

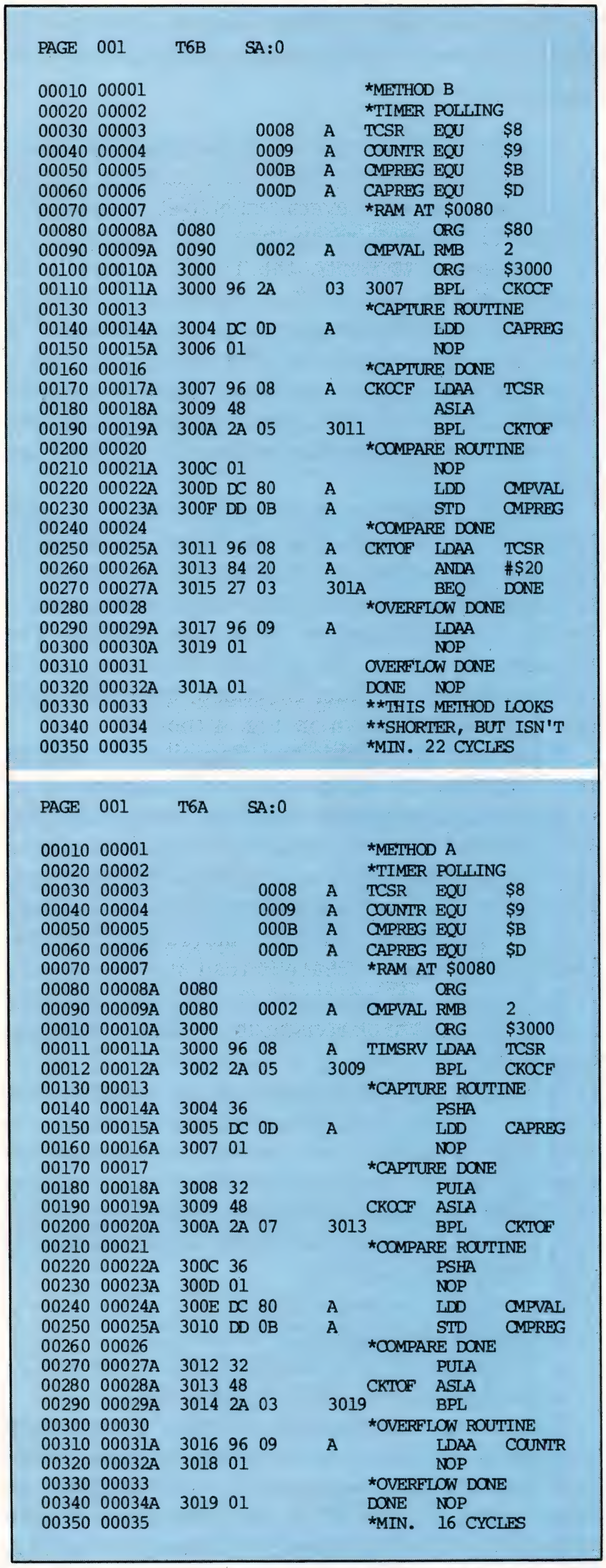
When both the enable and flag bits of a desired timer function are set, an interrupt is generated. If, in addition, the processor-interrupt mask bit is clear, the processor responds to the interrupt, vectoring to the unique service routine for that specific interrupt. Each different timer interrupt has its own vectored location. For solely interrupt-driven applications, the processor may not have to read individual timer flags; however, the processor retains this capability so that "polling" type recognition of timer functions can be used.

To assure that timer functions are serviced only once per request, each timer routine must clear its own flag bit before a service exit. A two-step bit-clearing sequence can easily be set up first by reading the TCSR at location $8 (assuming the flag bits are set), then by accessing particular timer registers to clear individual flag bits.

These register accesses include:

- Reading $D (CAPREG) to clear ICF.
- Writing $B, $C or both (CMPREG) to clear OCF.
- Reading $9 (COUNTR) to clear TOF.

This two-step bit-clearing procedure allows many sections of the processor program to access timer registers without inadvertently clearing flags. In these cases, the TCSR is not first read by the processor, so the flag bits are not armed for clearing. The program in Fig. 5 (top) uses this technique, reading the TCSR only once for three different purposes. Conversely, the program in Fig. 5 (bottom) repeatedly arms for clearing all timer flags by reading the TCSR three times. This denies the



```
PAGE  001     T6B    SA:0

00010 00001                          *METHOD B
00020 00002                          *TIMER POLLING
00030 00003             0008    A    TCSR   EQU    $8
00040 00004             0009    A    COUNTR EQU    $9
00050 00005             000B    A    CMPREG EQU    $B
00060 00006             000D    A    CAPREG EQU    $D
00070 00007                          *RAM AT $0080
00080 00008A  0080                          ORG    $80
00090 00009A  0090      0002    A    CMPVAL RMB    2
00100 00010A  3000                          ORG    $3000
00110 00011A  3000 96 2A       03    3007   BPL    CKOCF
00130 00013                          *CAPTURE ROUTINE
00140 00014A  3004 DC 0D        A           LDD    CAPREG
00150 00015A  3006 01                       NOP
00160 00016                          *CAPTURE DONE
00170 00017A  3007 96 08        A    CKOCF  LDAA   TCSR
00180 00018A  3009 48                       ASLA
00190 00019A  300A 2A 05       3011         BPL    CKTOF
00200 00020                          *COMPARE ROUTINE
00210 00021A  300C 01                       NOP
00220 00022A  300D DC 80        A           LDD    CMPVAL
00230 00023A  300F DD 0B        A           STD    CMPREG
00240 00024                          *COMPARE DONE
00250 00025A  3011 96 08        A    CKTOF  LDAA   TCSR
00260 00026A  3013 84 20        A           ANDA   #$20
00270 00027A  3015 27 03       301A         BEQ    DONE
00280 00028                          *OVERFLOW DONE
00290 00029A  3017 96 09        A           LDAA
00300 00030A  3019 01                       NOP
00310 00031                          OVERFLOW DONE
00320 00032A  301A 01                DONE   NOP
00330 00033                          **THIS METHOD LOOKS
00340 00034                          **SHORTER, BUT ISN'T
00350 00035                          *MIN. 22 CYCLES
```

```
PAGE  001     T6A    SA:0

00010 00001                          *METHOD A
00020 00002                          *TIMER POLLING
00030 00003             0008    A    TCSR   EQU    $8
00040 00004             0009    A    COUNTR EQU    $9
00050 00005             000B    A    CMPREG EQU    $B
00060 00006             000D    A    CAPREG EQU    $D
00070 00007                          *RAM AT $0080
00080 00008A  0080                          ORG
00090 00009A  0080      0002    A    CMPVAL RMB    2
00010 00010A  3000                          ORG    $3000
00011 00011A  3000 96 08        A    TIMSRV LDAA   TCSR
00012 00012A  3002 2A 05       3009         BPL    CKOCF
00130 00013                          *CAPTURE ROUTINE
00140 00014A  3004 36                       PSHA
00150 00015A  3005 DC 0D        A           LDD    CAPREG
00160 00016A  3007 01                       NOP
00170 00017                          *CAPTURE DONE
00180 00018A  3008 32                       PULA
00190 00019A  3009 48                CKOCF  ASLA
00200 00020A  300A 2A 07       3013         BPL    CKTOF
00210 00021                          *COMPARE ROUTINE
00220 00022A  300C 36                       PSHA
00230 00023A  300D 01                       NOP
00240 00024A  300E DC 80        A           LDD    CMPVAL
00250 00025A  3010 DD 0B        A           STD    CMPREG
00260 00026                          *COMPARE DONE
00270 00027A  3012 32                       PULA
00280 00028A  3013 48                CKTOF  ASLA
00290 00029A  3014 2A 03       3019         BPL
00300 00030                          *OVERFLOW ROUTINE
00310 00031A  3016 96 09        A           LDAA   COUNTR
00320 00032A  3018 01                       NOP
00330 00033                          *OVERFLOW DONE
00340 00034A  3019 01                DONE   NOP
00350 00035                          *MIN.  16 CYCLES
```

5. Two simple routines use polling to examine the timer contents; the one on top requires six more cycles. The program on bottom, by servicing all timer functions before rereading the TCSR, can access any time register any time without prematurely clearing timer-flag bits.

programmer free access to all timer registers without clearing a potentially unrecognized flag. The top program in Fig. 5a is better because all timer flags are recognized when the bit-clearing mechanism is armed.

The flag-clearing technique is handy when the timer service is performed through polling, since one read of the TCSR will simultaneously arm bit clearing and bring the timer flag bits to the processor.

Interrupts can substitute for polling

The timer subsystem can operate with synchronous or asynchronous system events. When all timed events are synchronous their occurrences are predictable and could be controlled through properly correlated polling routines. Asynchronous events, however, are better handled using interrupts to eliminate the necessity of event-timing correlation.

The timer subsystem has timed input and output transitions and monitors the passage of time—all potentially asynchronous events that could cause almost coincidental interrupts. This could force the processor to determine which gets serviced first, or the requests could suffer some delays if the processor is currently occupied with another interrupt task.

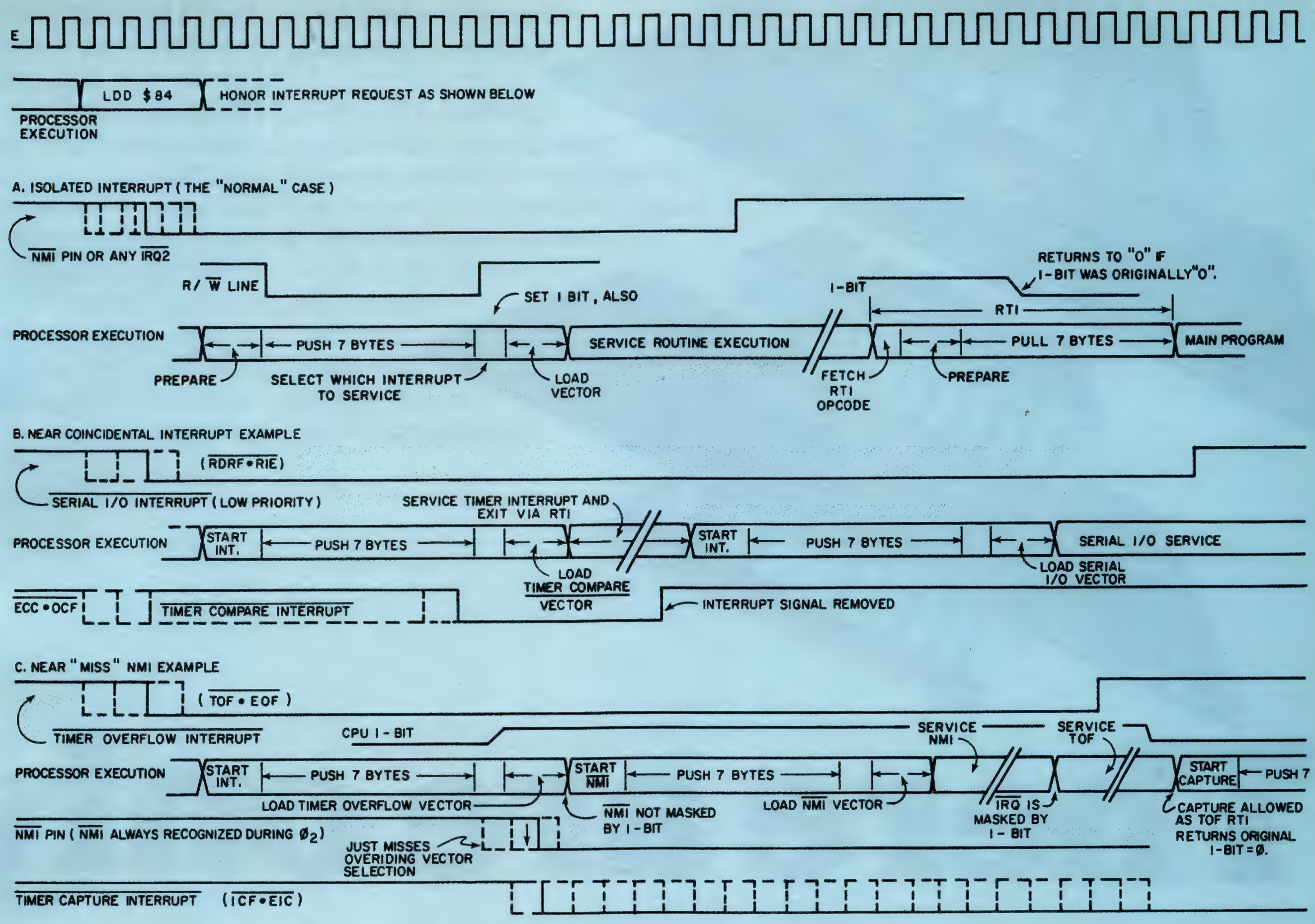
While the delays will not affect the actual output transitions on P_{21} or the input captures on P_{20}, they could hold up processor notification—and influence program control.

The MC6801 includes eight vector allocations that can support 12 varieties of interrupt operation. The vectored locations reside at the top of the memory map and take up 16 bytes of either internal or external ROM, depending on the operating mode selected for the processor. Restart occurs when the processor's reset pin is held low for at least three complete cycles, and then goes high.

Two cycles immediately following restart are used to read and transfer the 2-byte restart vector to the program counter. The third cycle begins the actual program execution as the first operation-code fetch occurs. At this time, the processor will be free from all interrupts except NMI (nonmaskable interrupt), SWI (software interrupt) or another restart, because the interrupt mask bit, I, in the condition code register has automatically been set.

NMI is nonmaskable by design, but SWI occurs any time its machine code ($3F) is encountered in the program (SWI does not become a NOP just because the I bit is set). When the processor clears its I bit, interrupt IRQ1 is free to occur. In addition, the four IRQ2 interrupts are also permitted when I=0 but require that individual interrupt-control-enable bits be set in the processor.

Processor execution is never diverted by any interrupt request until the current instruction has been



6. Interrupt-driven timer control enables the processor to handle asynchronous events efficiently. Three examples of various interrupt cases are shown here: a normal interrupt (a), a near-coincidental interrupt (b) and a near-miss (c).

completed. Most 6801 commands require two to six cycles, but the ten-cycle MUL and 12 cycle SWI could greatly delay interrupt response if the interrupt comes in at the beginning of the instruction. And, if several interrupts come in coincidentally, the processor must handle the request starting with the highest-priority signal.

Once recognized, all interrupts have similar effects on program execution:

- The processor pushes its program counter, index register, accumulators and condition-codes register onto seven bytes of the stack (not done for restart interrupt).
- The I bit of the condition-code register is set to inhibit further interrupts (except NMI, SWI and restart). The original state of the I bit has been preserved on the stack. Meanwhile the processor, having prioritized the interrupt requests, gets ready to select the highest one for actual service. (For any IRQ2, this is cycle 10 of 12 in Fig. 6.)
- The appropriate interrupt vector is then read by the processor and the appropriate location contents are transferred to the program counter.
- Interrupt service begins with program execution at the vector address.

Several examples of interrupt behavior are shown in Fig. 6., including normal, near-coincidental and near-miss. In Fig. 6a, a normal interrupt shows how requests are honored, serviced and exited very easily. In Fig. 6b, nearly coincidental interrupts are serviced according to priority. Once the priority is selected, the I bit is set so that service can continue uninterrupted. The bit will be restored to its previous condition as an RTI instruction restores the original condition codes in the condition-code register.

NMI, which, of course, is never masked, can override other interrupts (Fig. 6c), but must wait until the end of the current instruction. In this case, NMI occurs too late to overrule vector selection but early enough to postpone actual timer-overflow service. Neither IRQ1 nor other IRQ2 interrupts can do this because they cannot be recognized until the I bit returns to zero.□

How useful?	**Circle No.**
Immediate design application	547
Within the next year	548
Not applicable	549

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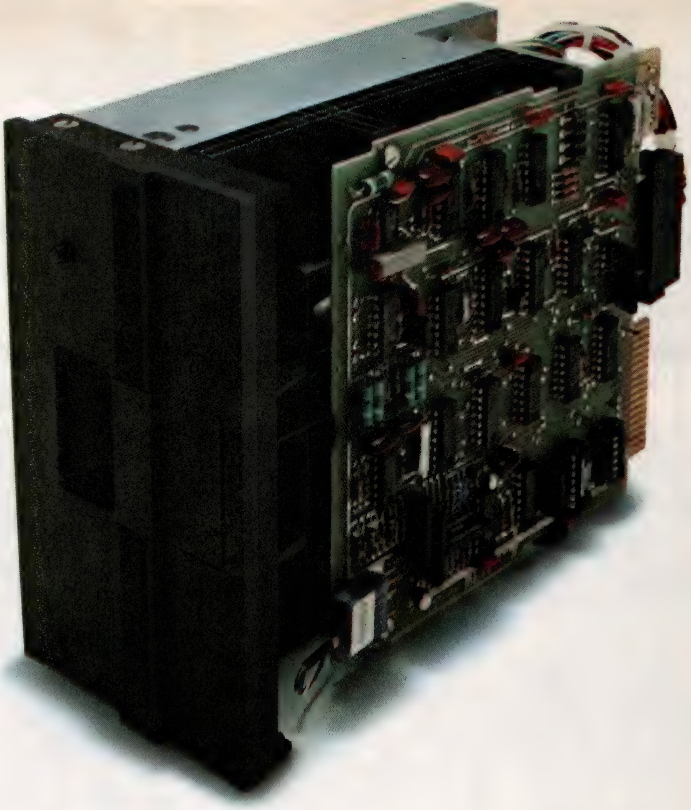

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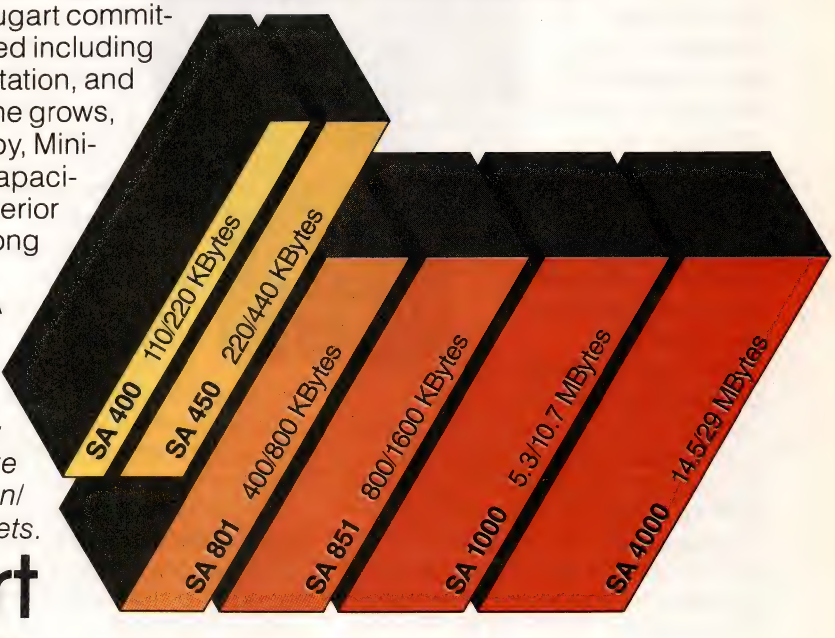

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CIRCLE NO. 36

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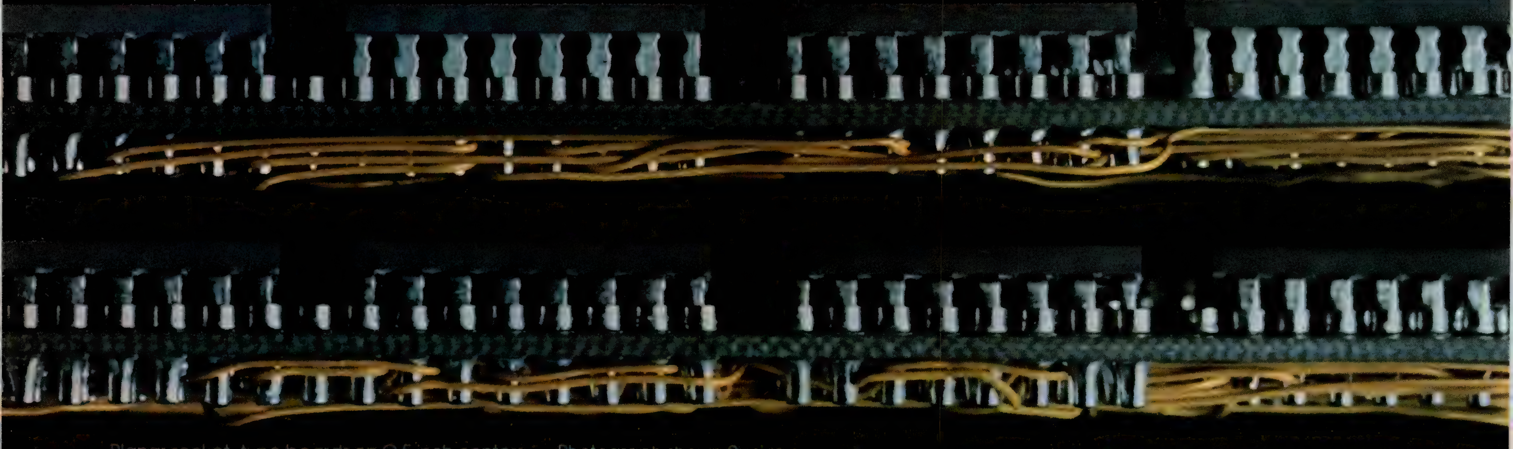

Planar socket-type boards on 0.5 inch centers. Photograph shown 2x size.

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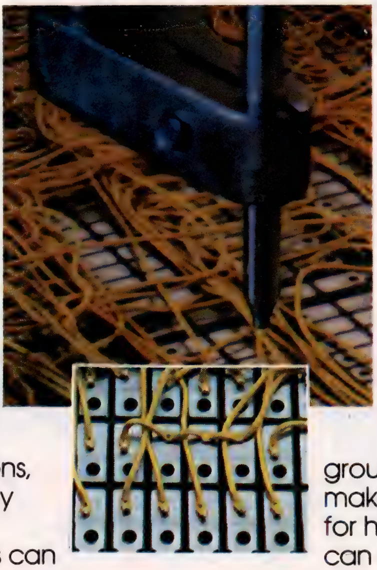

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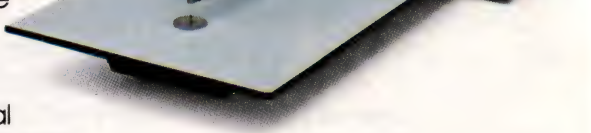

Augat Portable stitch-wire machine, Model LC 8000

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CIRCLE NO. 37

To upgrade from 16-kbit dynamic RAMs to 64-k without adding complexity to the memory system, use interchangeable, 5-V-only devices.

Single-supply 16-k, 64-k RAMs simplify upgrading

Designing a system around interchangeable single-supply 16-kbit and 64-kbit dynamic RAMs will clear the way to upgrading and its benefits—quadrupling memory capacity, for starters. However, designers approaching a 64-k RAM system design for the first time will still have a lot to consider, including:

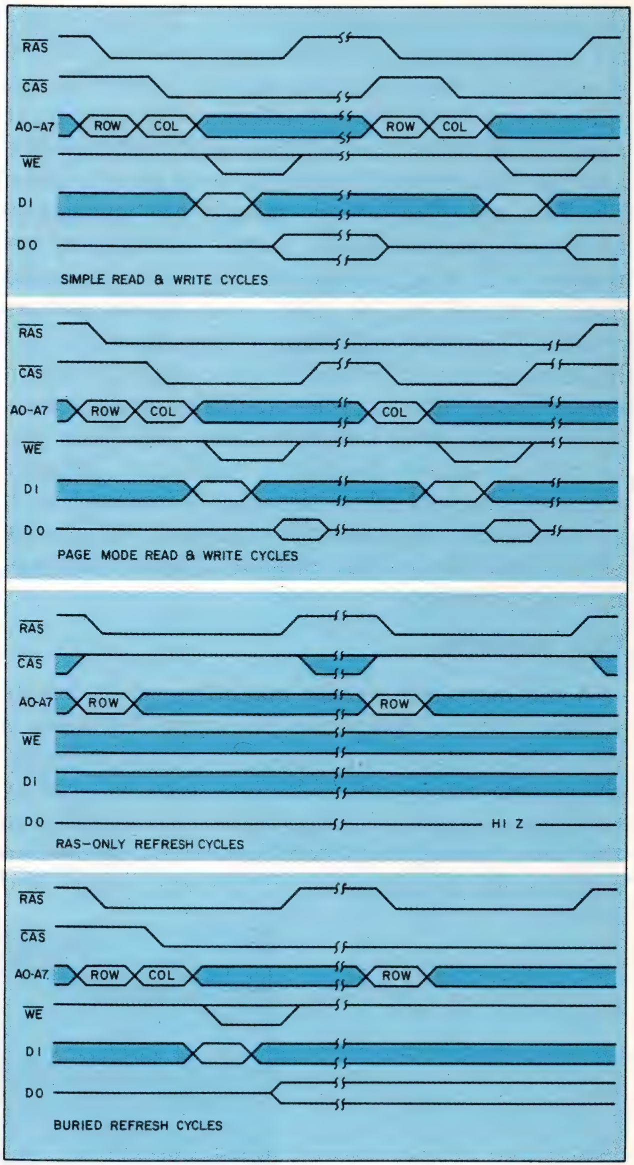
- Soft errors due to alpha particles—a problem at 16 k and a bigger one at 64 k
- Refresh-circuit operation
- Higher speeds—and the delay and impedance problems that arise
- Distributing the "clocks" from the decoder/drivers to the memory devices.

One problem noticed at the 16-k level and becoming more noticeable as density reaches the 64-k level is that of alpha-particle sensitivity. Soft errors caused by alpha-particle hits have grown in number as memory device storage cells shrink.

Fortunately, the errors are few, and even these few can be minimized not only with proper system design but also with proper memory-cell design and choice of packaging material. For example, the charge stored in National's 64-k RAM cell is more than in most other vendors' 16-k RAM cells, thus minimizing the effect of an alpha-particle hit. The larger charge is made possible by the use of a triple polysilicon cell structure (see "The Third Layer").

To counter those soft errors that do occur, though, redundancy and error correction can be added. Whenever errors are found, the address-refresh controller can cycle through the entire address space and perform read-modify-writes.

Traditionally, as dynamic RAMs have increased in density, refresh overhead has also increased,



1. Timing waveforms for the 5-V, 16-kbit NMC5295 and 5-V, 64-kbit NMC64164 are identical as well as compatible with older, multiple-supply, 16-kbit dynamic RAMs. However, the older devices cannot perform buried refresh.

Fred Smith, Engineering Manager, Memory Design
Robert Yu, Section Head, Memory Design
National Semiconductor
2900 Semiconductor Dr., Santa Clara, CA 95051

cutting a system's overall operating efficiency. However, the latest generation of single-supply dynamic devices, such as the NMC5295 16-kbit and NMC4164 64-k RAMs, actually reduce refresh overhead (defined as the number of refresh cycles multiplied by the cycle time, with the result divided by the refresh interval).

For the NMC5295 and NMC4164, the refresh overhead has been cut to at least 1.6%, compared to about 2.4% for earlier 16-k RAMs. This reduction results from the use of a 4-ms refresh interval for the NMC4164 as well as improved cycle times for both parts (see Table).

Even though the refresh interval for the NMC4164 increases to 4 ms, and the refresh interval for the NMC5295 stays at 2 ms (like the older 16-k RAMs), the timing requirements for each of the new RAMs are compatible with the other and with the industry standard for older multiple-supply RAMs (Fig. 1).

Besides the conventional read and write cycles that automatically perform a refresh at the selected row address, two other refresh-cycle types are available. The RAS-only refresh mode, used in previous generations of dynamic RAMs, keeps the memory refreshed with minimum power. A new mode, called buried refresh, can be used where power isn't as critical. It permits valid data to remain on the bus by keeping CAS active while RAS is cycled to perform one or more refresh cycles at different addresses. Note, however, that a small system—less than, say, 64 kwords—is not likely to use the new dynamic memories because of the associated overhead, such as the refresh counter and multiplexer. Here, new pseudostatic devices can provide a much more economical approach.

Easy upgrading

While increased density magnifies the problems apparent at the lower level, the upgrading itself is easy with compatible devices. If designed properly, the system can permit 16-k units to be replaced by 64-k devices just by making some minor changes to the board during production. As a result, production systems can be upgraded without any rework and memory density can be quadrupled when the economic factors justify the changeover. For these reasons, the NMC5295 and NMC4164 have fully compatible pinouts (Fig. 2). The extra address line (A_7) required by the 64-k NMC4164 is now located on pin 9, which is not used on the NMC5295. This pin is also compatible with other single-supply 16 and 64-k RAMs coming from other manufacturers.

However, not every single-supply 16 and 64-k memory will be compatible. A few 64-k RAM manufacturers (Motorola and Mostek, for example) have included a special refresh function on pin 1 of the package. This pin is not used by the NMC4164 (or on Texas Instruments' TMS4164 dynamic RAM). What's more, total compatibility may not even be possible between Motorola and Mostek devices because of differences in refresh operation. Adding even more to the confusion, Motorola and Mostek use a 128-cycle/2-ms refresh while both National and TI use a 256-cycle/4-ms refresh design.

With refresh functions and sense amplifiers adding to chip area, which directly affects cost, a single standard would be the most cost-effective product. Until that standard comes through, however, a simple system design, like the one shown in Fig. 3, provides the flexibility to cover all eventualities.

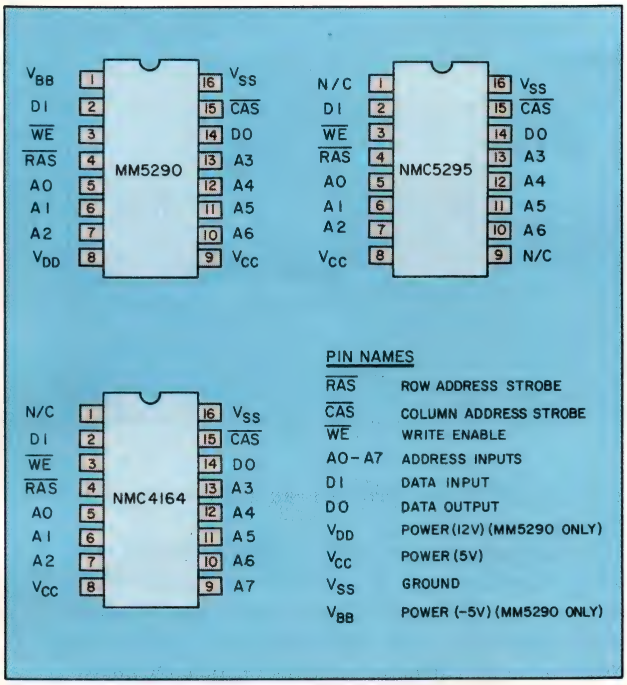
In the system, the row and column addresses are multiplexed onto the 8-bit address bus for the 16 or 64-k RAMs. This system requires an 8-bit refresh counter clocked 128 times every 2 ms. Then the eighth bit cycles every 4 ms. The first seven bits provide the 128 addresses required by the 16-k RAMs and some 64-k RAMs. For these devices, the eighth bit can be ignored, since the state of this address to the RAM is a "don't care" during refresh. However, the correct signal is available on the eighth bit as required for the 256-cycle/4-ms RAMs.

The refresh flexibility of the system comes at negligible extra system cost, requiring just the eighth bit of a refresher counter and the extra printed-circuit trace between the counter and the multiplexer. Thus, for almost no additional cost, both 16 and 64-k RAMs can be used on the same PC board.

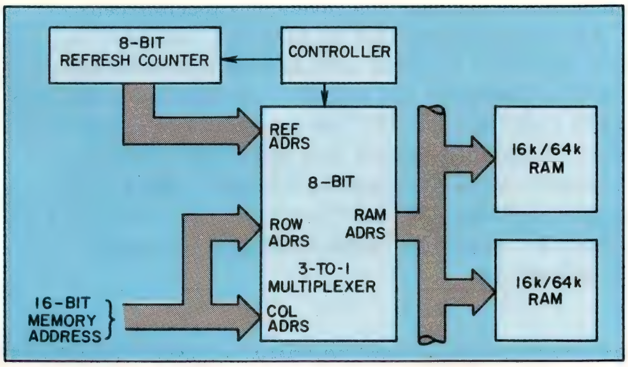
Putting in the denser devices is simple enough, but

Current and next-generation dynamic RAMs

	MM5290	NMC5295	NMC4164
Power supplies	+12 V,+5 V,−5 V	+5 V	+5 V
Memory configuration	16,384×1-bit	16,384×1-bit	65,536×1-bit
Access time (ns)	120, 150, 200	80, 100, 120	100, 120, 150
Cycle time (ns)	375	200	250
IDD current			
—active (mA)	35	35	35
—standby (mA)	1.5	4	4
Refresh cycles/ interval (ms)	128/2	128/2	256/4



2. Pinouts for the 5295 and the 4164 are compatible, except for the extra address line needed by the 64-kbit device.



3. Building a memory system using either the 16 or 64-kbit single-supply dynamic RAM requires the same basic building blocks as in earlier systems. The only major changes include the use of an 8-bit refresh counter and multiplexer, and a reduction in the power-supply complexity and board layout.

getting them to function effectively within the system is more difficult. Not only are single-supply 64-k RAMs denser, they are faster as well—a quality that, while desirable, can affect the surrounding system design.

Access and cycle times hinge on the delays within the memory device itself and the delays in the logic surrounding, and feeding the memory devices. When the memory-device-related delays were on the order of 400 to 500 ns, the designer had no problem realizing system access times of 500 to 700 ns—the controllable external delays were only 20 to 30% of the total delay.

However, the newer devices have access delays around 100 ns, which means the external delay times now represent about 50% of the total system access time. Thus, to get the same level of performance, external delays must be reduced to 20 to 30 ns—a problem for designers not used to high-speed logic.

It may also be time to consider new memory organizations at the systems level. For example, pipelining might be carried deeper into the memory module to obtain more overlap in the memory cycle. Many systems take advantage of small module sizes to increase the system's data bandwidth by using overlapping and interleaved memory cycles. However, when changing to a 64-kbit memory increment, designers must note that this larger memory "granularity" may cause problems in overlapping or interleaved memory schemes. This problem should prove familiar—some designers ran into it when memory systems switched from 4 to 16-kbit devices. More will notice it as systems switch from 16 to 64 k.

Another problem related to increasing speed is the need for low-impedance distribution of power. The 5-V RAMs have very fast access times because they switch internal modes very quickly. This also produces short but large current spikes with fast rising and falling edges. To maintain good, clean voltages at the device pins, the power-distribution system must have a low impedance at high frequencies, i.e., a low inductance.

Low-impedance supplies

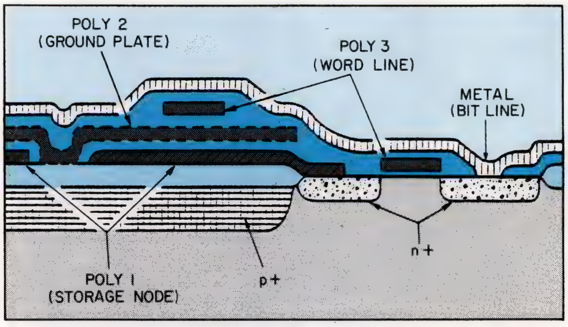
The best way to ensure a low-impedance supply is by dedicating two planes or layers of a PC board to the distribution of 5 V and ground, and bypassing each device with a good, high-frequency, 0.1-μF disk or chip ceramic capacitor. A less expensive approach uses a power-distribution grid on a double-sided board along with the bypassing capacitors for every device.

Note, however, that the 64-k RAM can typically be justified for production systems at a cost of about \$20 to \$40 per device. If a typical memory card holds 100 RAMs, then the silicon cost becomes \$2000 to \$4000. Thus, since a multilayer card can improve margins at the system level by lowering the power-supply impedance, it's often worthwhile to spend the extra \$80 or so for the card to get the extra layers and margins.

Another problem to be solved is how to distribute clock signals from the decoder/drivers to the memory devices. The RAS, CAS, WE drivers should be located near the center of the array and the RAS, CAS and WE lines should be distributed in a "star" (radially from the drivers). Provisions should be made for either terminating these lines or for controlling the rise and fall times with damping resistors.

For the best performance when using damping

The third layer



The triple-polysilicon dynamic-memory cell, with its modest design rules and lack of esoteric cell designs, adds more than just another polysilicon layer to dynamic-memory designs. It also adds a special capacitor that, along with the third layer of polysilicon, provides more efficient use of chip area.

Most 4-k units use a single polysilicon layer with a one-transistor memory cell. For 16-k-generation devices, a second polysilicon layer was added to provide a more efficient layout for the memory cell and reduce the requirement for extensive feature-size reduction or electrical scaling. Unlike the previous-generation cells, however, the triple-poly cell uses a polysilicon-dielectric-polysilicon (PDP) storage capacitor. The capacitor is formed between the first poly storage node and the second poly, which serves as a common ground plate. The third layer is used for the word line.

A buried contact in each cell connects the first polysilicon layer's storage node to the source of the switch transistor. The drain of the transistor is connected to the metal bit line by a shared contact. A second word line runs over the top of the PDP capacitor and forms the switch transistor for the adjacent cell. Having each word line select alternate memory cells in this way fits well with the new sense-amplifier configuration developed for both the NMC5295 and NMC4164.

The PDP capacitor, together with the third layer of polysilicon, provides a very efficient use of chip area. In fact, the capacitor occupies close to half of the total memory-cell area, which is about twice the efficiency achieved by previous designs. Besides allowing a larger capacitor for a given memory cell area, the PDP cell provides an improved-quality storage medium.

In conventional inversion-capacitor designs, the total capacitor area is subject to leakage from junction to substrate, a situation that is considerably improved for the PDP cell. Only about 20% of the total memory capacitor area is formed by an N^+ junction that can leak to the substrate. The major portion of the capacitor is formed by two polysilicon plates separated by a high-quality dielectric. Thus, refresh characteristics of the PDP memory cell are much improved over the inversion-capacitor cells.

Another problem with an inversion capacitor is that the entire capacitor area acts as a collector for carriers generated by ionizing radiation such as alpha particles. The PDP cell can reduce this problem considerably because only 20% of the capacitor is formed by the N^+ junction to the substrate, which greatly reduces the collection efficiency for extraneous carriers, and thus minimizes the number of soft errors.

resistors, the resistors should be located in series with the line at the point where the line enters the array. The resistors should be low-inductance types (1/4-W carbon compositions are preferred to film resistors). Fast diodes to well-bypassed, low-impedance clamp references have been used most successfully when the line-termination technique was used. The references should be a diode drop above ground for the negative-going clamp and a diode drop below 5 V for the positive-going clamp.

Power dissipation in the memory array can be minimized by decoding the clocks with the chip-select addresses. Refresh power can also be minimized by making the refresh rate a function of temperature. Before doing this, note that the temperature of interest is that of the hottest memory device. The worst-case power dissipation of a RAM occurs only when that chip is being accessed by the system at a maximum rate. Unfortunately, this situation can arise easily in many computer systems. A reasonable compromise is to refresh at the maximum rate (256 cycles/4 ms) except in standby, where the refresh rate can be made lower at lower temperatures.

To keep the temperatures down, check the rate of air flow over the board, which will help determine the best way to lay out the RAMs. At low air speeds, maximum cooling can be obtained by aligning the rows of pins with the flow of the air. If the air speed is fast enough to be turbulent over the card surface, it is better to situate the rows of pins across the air flow. However, very few systems usually have that turbulent an air flow.□

How useful?	**Circle No.**
Immediate design application	550
Within the next year	551
Not applicable	552

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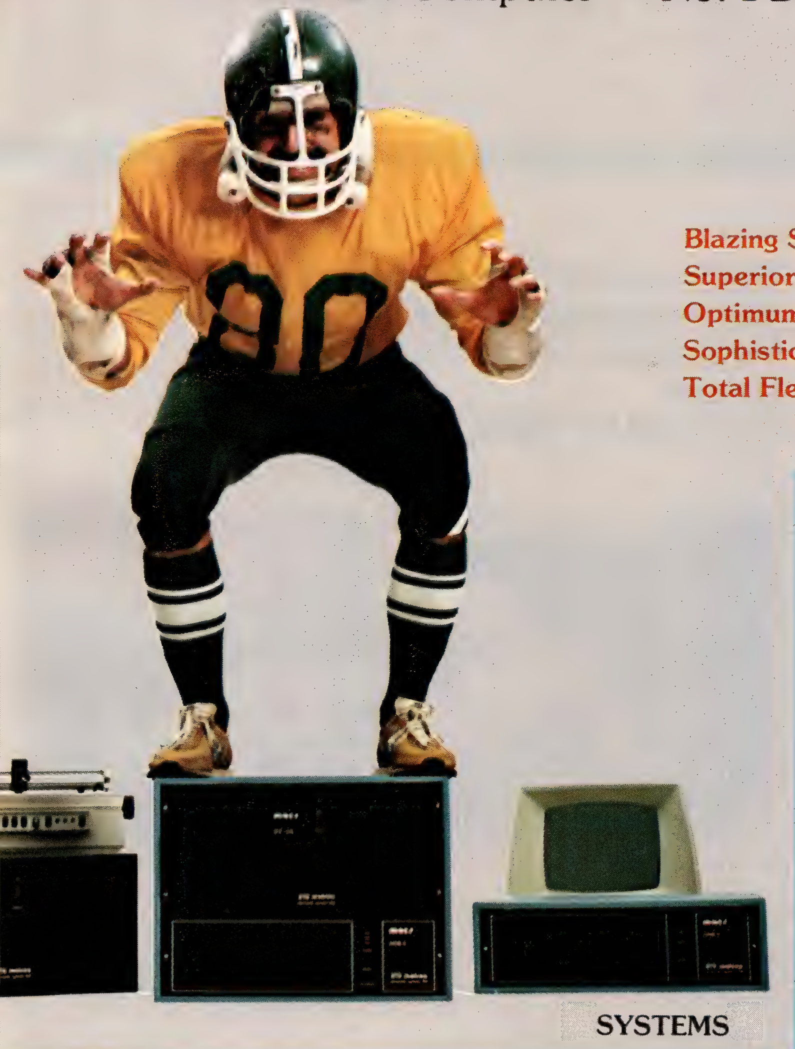

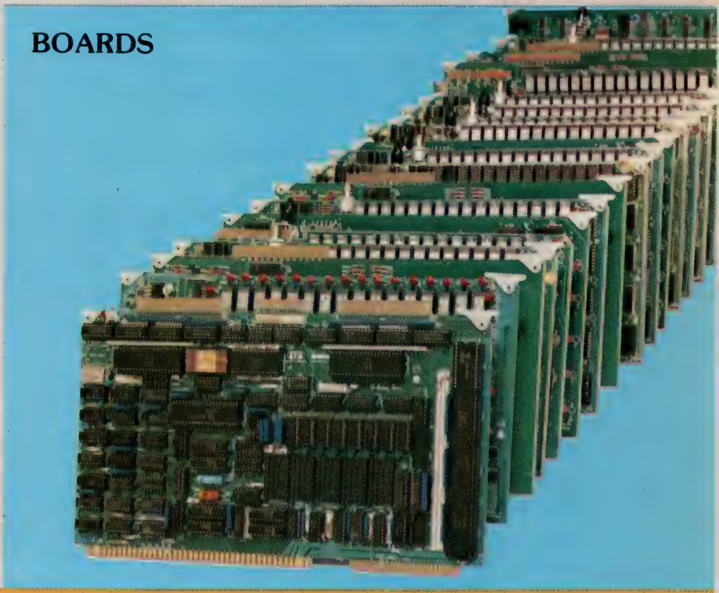

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CIRCLE NO. 38

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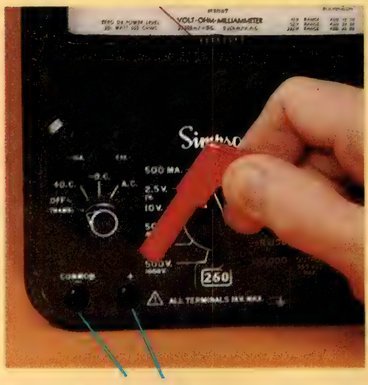

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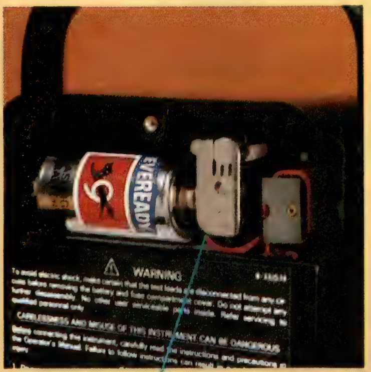

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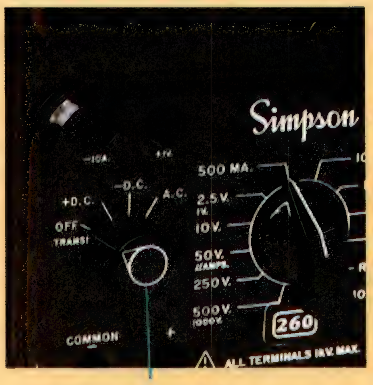

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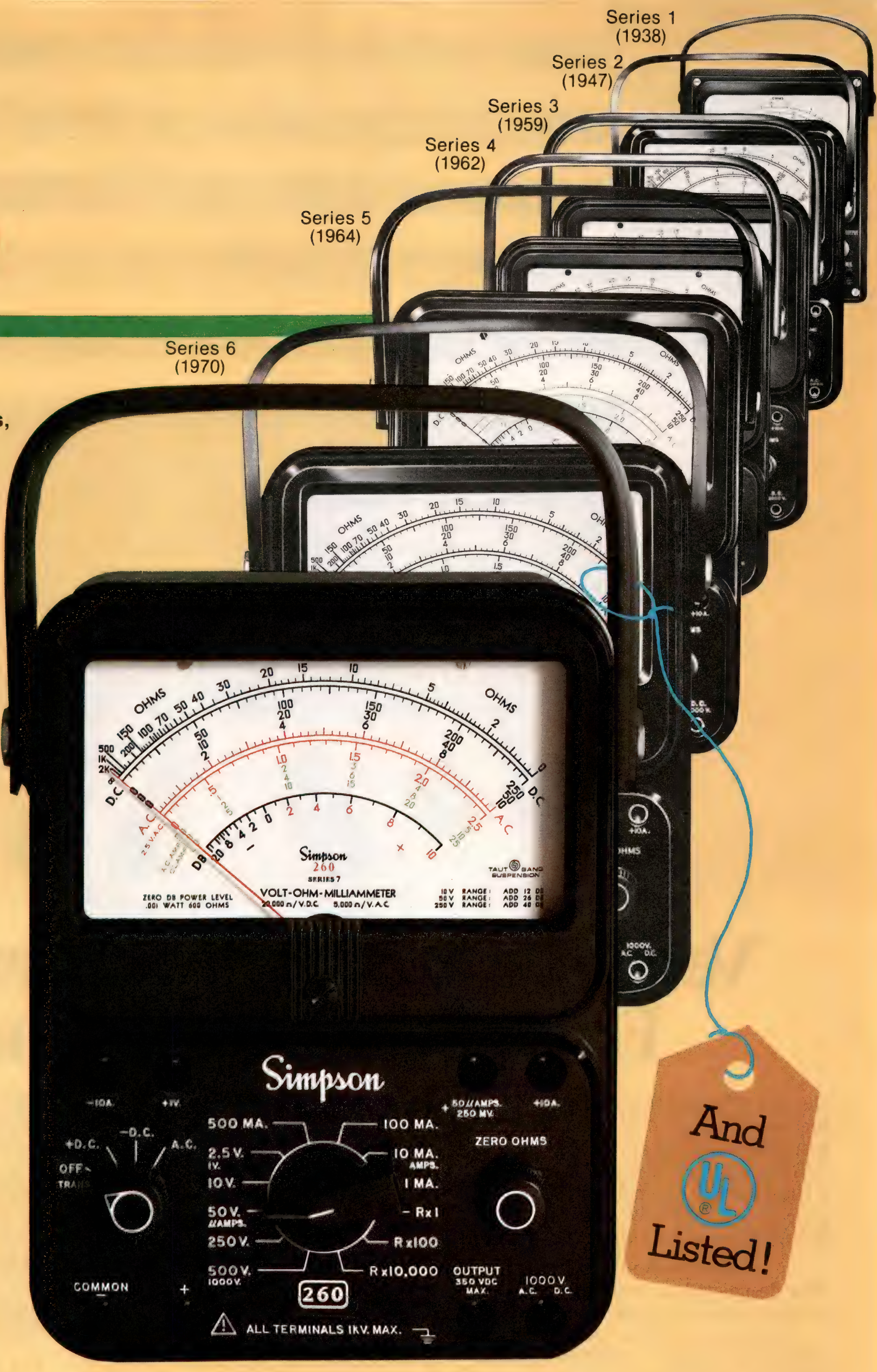

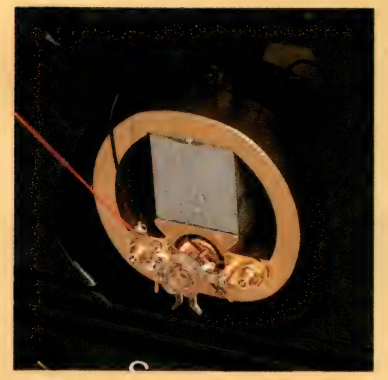

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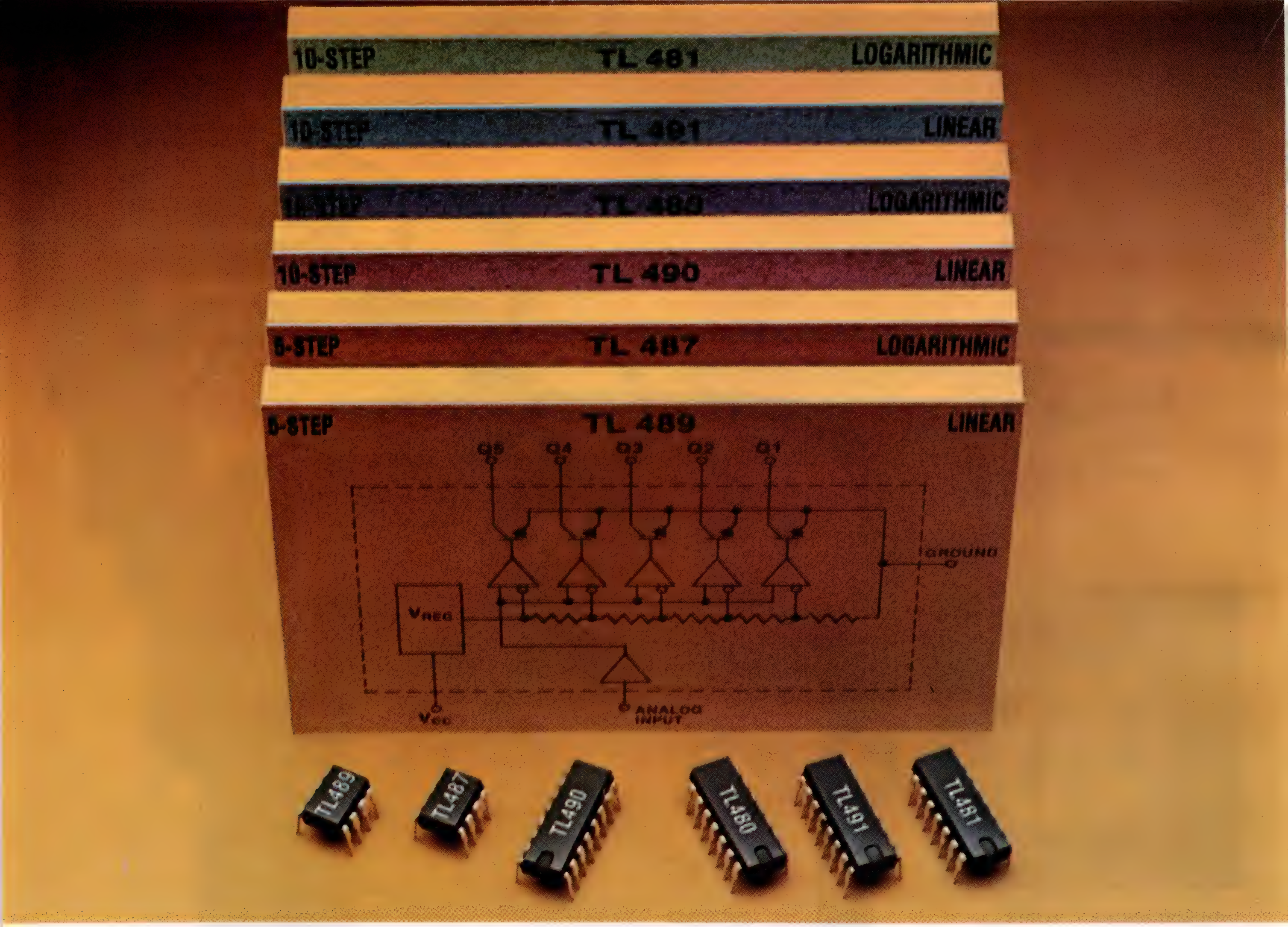
CIRCLE NO. 39



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CIRCLE NO. 40

Derived from techniques similar to those that approximate small-scale s parameters, the large-scale s parameter identifies the source of instability in a single-stage amplifier or a simple transistor stage.

Large-scale s parameters help analyze stability

Large-scale s parameters unearth instability in a single-stage amplifier or a simple, Class-B or C transistor stage—for all possible frequency, load and source conditions. Manual calculations are unnecessary; several time-sharing services offer a circuit analysis program, called Compact, that lets a computer grind out the values. The program accepts s-parameter data and performs the required stability calculations.

Theoretically, s parameters assume linear operation; but the techniques that measure small-signal s parameters can be adapted to give s parameters that are useful in determining the stability of large-signal amplifiers (see "The Measure of an s Parameter"). Sometimes direct measurement of a large-signal characteristic is impractical. Instead, a bare-bones amplifier containing a transistor (and designed by rule-of-thumb) becomes the unit under analysis. Even with this procedure, s parameters are accurate only for predicting stability and must, therefore, be used cautiously.

Finding the source of instability

To determine if any source or load-impedance values will make the unit unstable, calculate the magnitude of $s_{12} \times s_{21}$ for all frequencies at which the device gain (the magnitude of s_{21}) is equal to or greater than unity. Calculate this quantity at several frequencies until the device is completely characterized. The device is stable if:

$$|s_{12}\, s_{21}| < 1 - |s_{11}|^2 \qquad (1a)$$

and

$$|s_{12}\, s_{21}| < 1 - |s_{22}|^2 . \qquad (1b)$$

To identify all input impedances that can make a device unstable, calculate:

$$r_{11} = \frac{M^*}{|s_{11}|^2 - |D|^2}, \qquad (2)$$

where

$$M = s_{11} - D\, s_{22}^*$$

and

$$D = s_{11}\, s_{22} - s_{12}\, s_{21}.$$

On a Smith Chart, r_{11} is the center of a circle with radius:

$$P_{11} = \frac{|s_{12}\, s_{21}|}{\left|\, |s_{11}|^2 - |D|^2 \right|}. \qquad (3)$$

The stable region for these impedances may be either inside or outside the circle. If

$$(P_{11} - |r_{11}|)\,(1 - |s_{11}|) \qquad (4)$$

is positive, the stable region is inside the circle; if negative, outside. Source impedances falling in the unstable region may cause the circuit to oscillate.

To find the output-impedance stability circle, calculate the center:

$$r_{22} = \frac{N^*}{\left|\, |s_{22}|^2 - |D|^2 \right|}, \qquad (5)$$

where

$$N = s_{22} - D s_{11}^* ,$$

and calculate the radius:

$$P_{22} = \frac{|s_{12}\, s_{21}|}{\left|\, |s_{22}|^2 - |D|^2 \right|} . \qquad (6)$$

The stable region of output-impedance values will lie inside or outside the circle, depending on the sign of:

$$(P_{22} - |r_{22}|)\,(1 - |s_{22}|) \ . \qquad (7)$$

A positive value places the stable region inside the circle; a negative value, outside.

In other words, expressions 1a and 1b determine whether any combination of source or load impedances could generate a negative resistance. Expressions 2, 3, 5 and 6 describe the boundary between the stable and unstable regions. Expressions 4 and 7 indicate which of the regions is stable by determin-

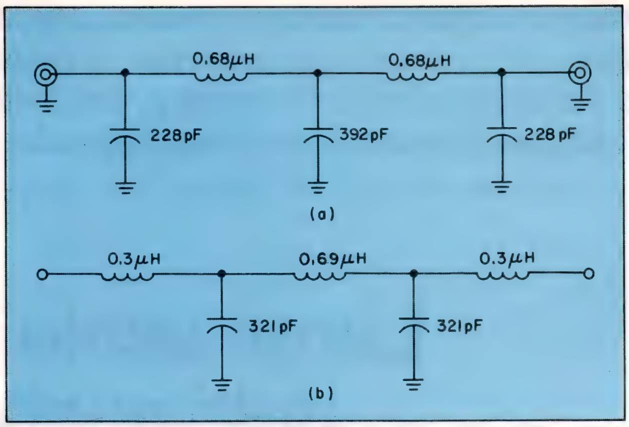
R. Jack Frost, Senior Electronic Engineer
Electronics Division, General Dynamics
P.O. Box 81127, San Diego, CA 92138

ing whether the 50-Ω test point, at the center of the Smith Chart, is inside or outside the stability circle.

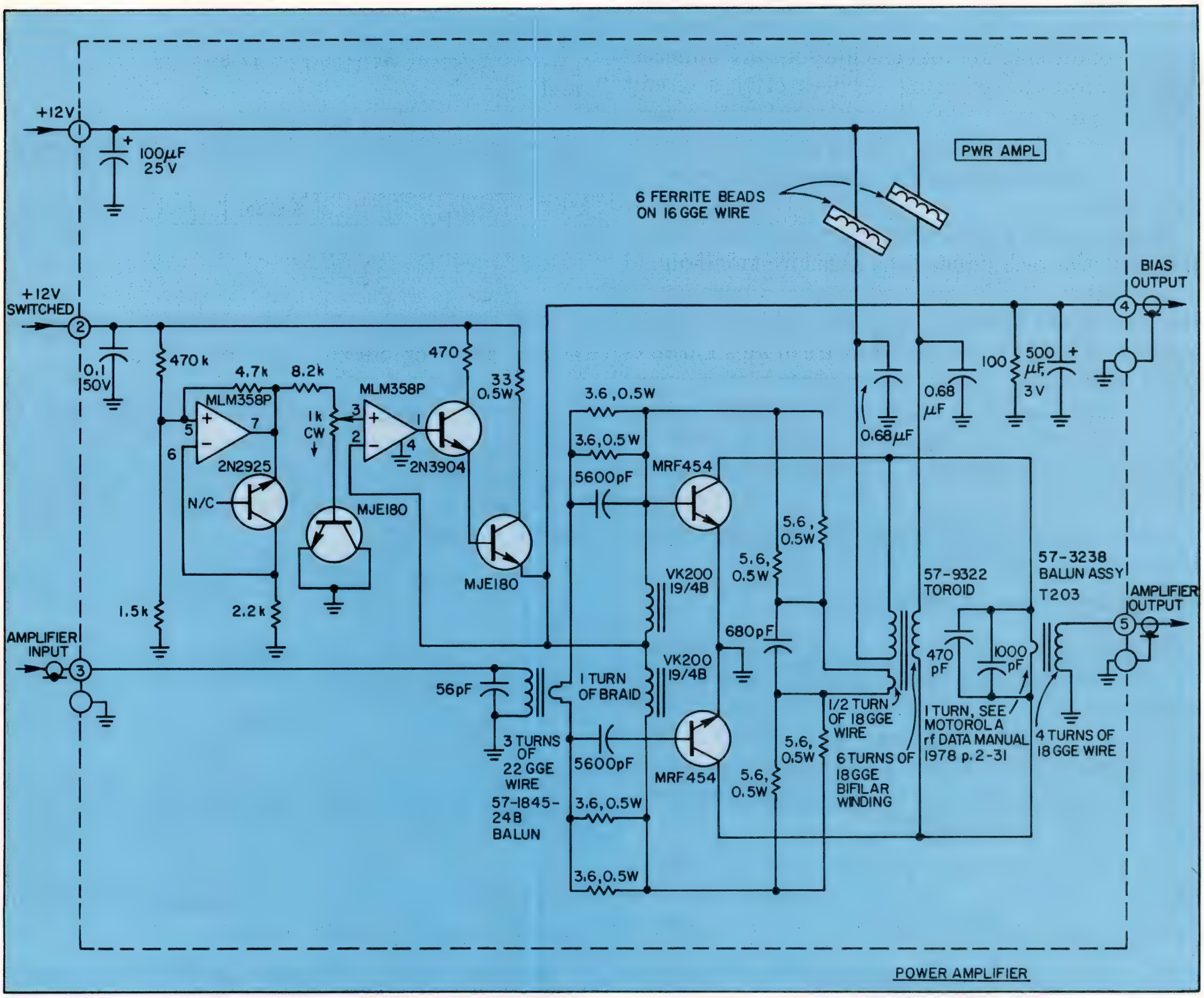
Stabilizing an amplifier

As a sample of application of the large-signal s-parameter technique, the Motorola power amplifier in Fig. 1 may be stabilized for 20-m operation. The 2 to 30-MHz rf power amplifier must have harmonic suppression exceeding 40 dB. The first configuration (Fig. 2a) employs a low-pass output filter which makes the circuit unstable. The cause of the instability does not appear when the filter's swept-frequency response is plotted on the Smith Curve in Fig. 3; but it is identified by applying large-signal s parameters.

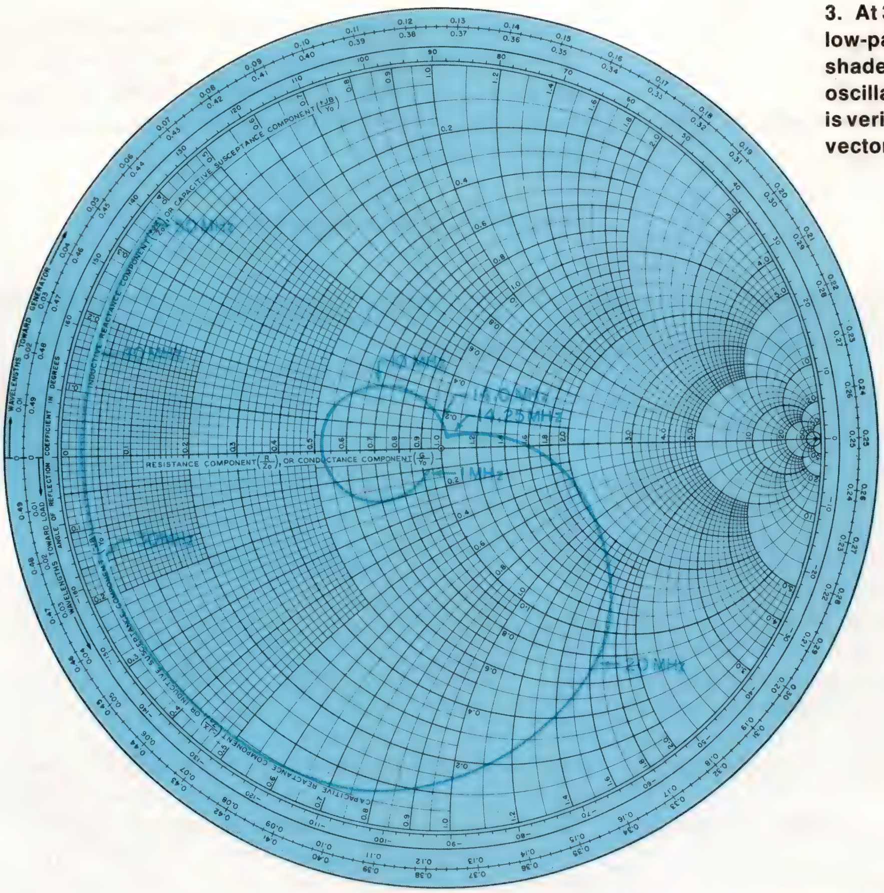
The 20-MHz large-signal s-parameters in the table, measured at a quiescent bias current of 5 A (2.5 A per output transistor), give the following results at



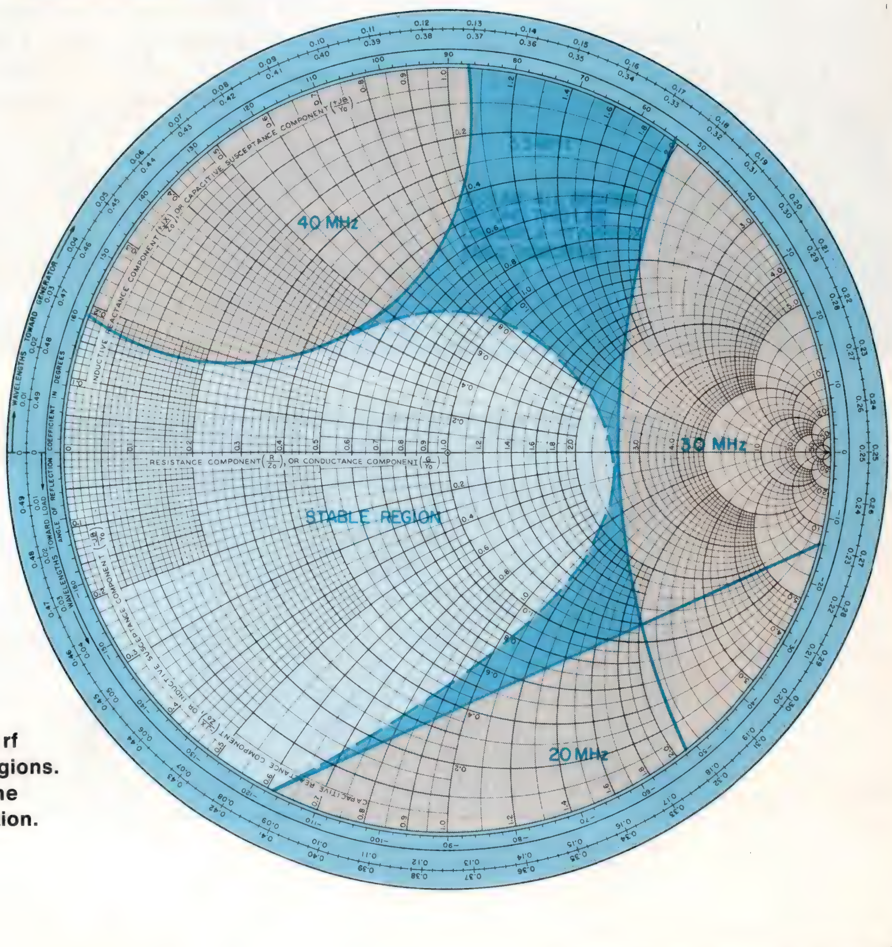
2. Although it provides the required harmonic suppression, a low-pass filter (a) causes oscillations. The filter shown in (b) improves the overall amplifier stability, without sacrificing harmonic suppression.



1. In the design of a 2 to 30-MHz, 100-W amplifier, the amplifier is treated like a single device so that the measured s parameters can determine stability. The s-parameter measurements include the effects of all bias circuitry.



3. At 30 MHz, the input impedance of the low-pass filter in Fig. 2a falls within the shaded area shown in Fig. 5, and oscillations result. The unstable region is verified with an antenna tuner and a vector-impedance meter.



4. The input-stability circles for an rf power amplifier reveal unstable regions. Driver output impedances within the shaded regions may cause oscillation.

the amplifier-output port:

$$D = 0.3305 \ \underline{/200},$$
$$N = 0.7647 \ \underline{/-82}.$$

The center of the output-stability circle is then:

$$r_{22} = 1.58 \ \underline{/82},$$

and the radius is

$$P_{22} = 0.717.$$

Expression 7 reduces to −0.198. This negative value indicates that the stable region for the output impedance lies outside of the circle. Using the same s-parameter values for the amplifier-input-port calculation yields:

$$N = 0.3037 \ \underline{/66.2}$$

The center of the input-stability circle is:

The measure of an s-parameter

The procedure for approximating a large-signal s-parameter is based on the well-established method for small-signal class-A devices as outlined, for example, in H-P Application Note 95 (Hewlett-Packard, Palo Alto, CA). Familiarity with this process is essential before any attempt to measure large-signal s-parameters. In measuring large-signal s parameters, dc bias must be applied to the device under test, and test signals must have high amplitudes (−10 dBm); otherwise the procedure is identical to that for Class A. The bias can be inserted using a simple resistive network or rf choke; the required signal levels are within the usual range of network analyzers.

The setup in the top figure measures, s_{22} and s_{12}:

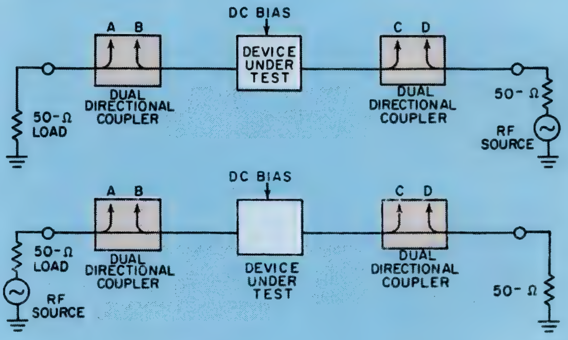
$$S_{22} = \frac{C}{D} \ \underline{/\phi_C - \phi_D}$$

$$S_{12} = \frac{B}{D} \ \underline{/\phi_B - \phi_D}.$$

Reversing the load and signal source changes the set-up to that in the bottom figure, for measuring S_{11} and S_{21}:

$$S_{11} = \frac{B}{A} \ \underline{/\phi_B - \phi_A}$$

$$S_{21} = \frac{C}{A} \ \underline{/\phi_C - \phi_A}.$$



To measure the large-signal s-parameters for a transistor or an amplifier, insert the device in the appropriate test configuration. Then adjust the dc bias and signal level so the s-parameter measured is at its large-signal value. The large-signal value can be recognized because additional changes in biasing or in the signal level do not change the s-parameter value. A good choice to start with is s_{11}. The result can be checked against the known value. (Large-signal values for s_{11} and s_{22} are usually expressed as Z_{11} and Y_{11}, respectively).

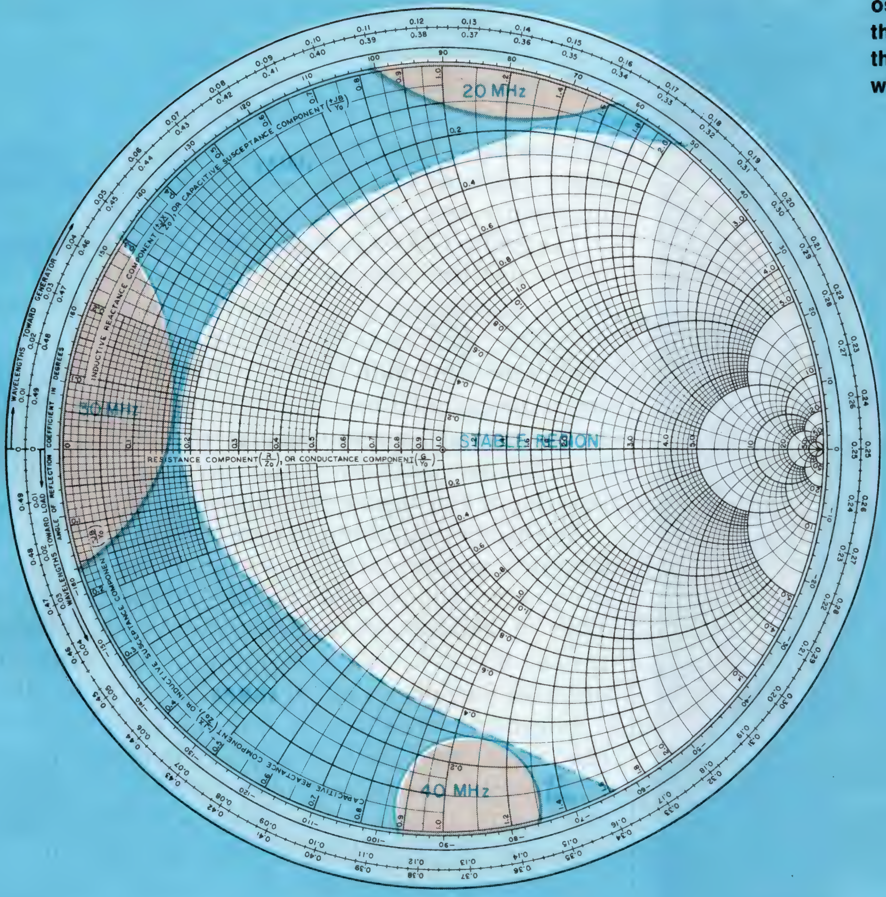
Be careful not to burn out the s-parameter test set when measuring the large-signal parameters of power amplifiers. These units, when unstable, can develop powerful oscillations. In particular, the s_{22} and s_{12} measurements should be made with extreme caution.

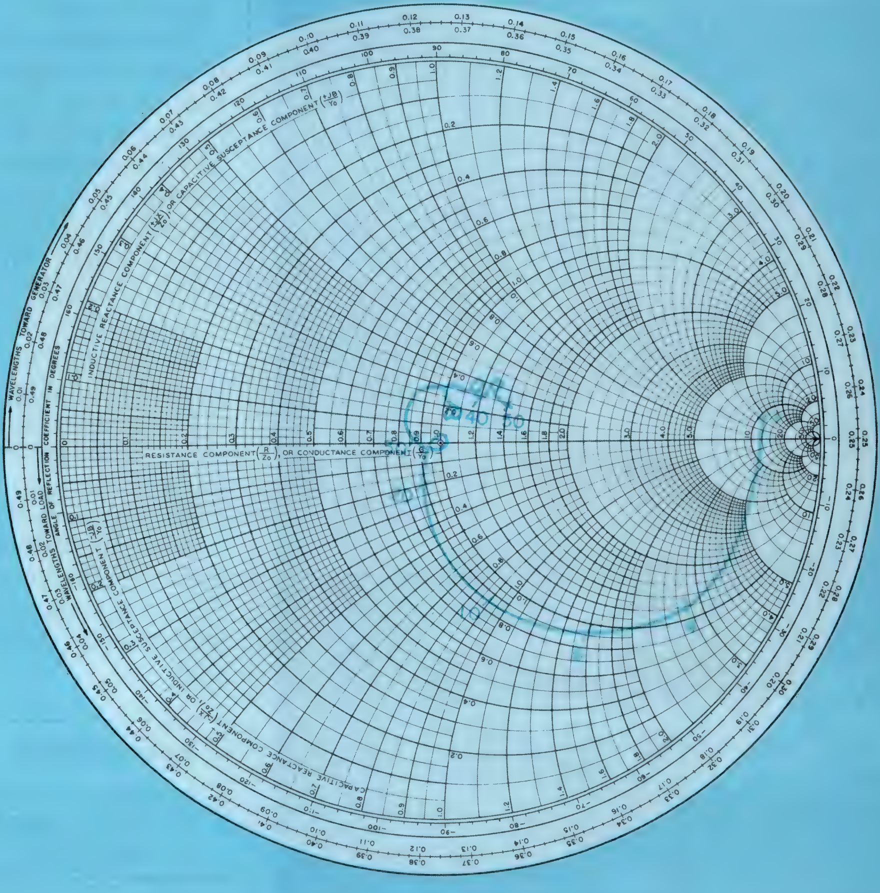
Large-signal polar s-parameters in 50-Ω system

Frequency (MHz)	S_{11} Magnitude < Angle		S_{21} Magnitude < Angle		S_{21} Magnitude < Angle		S_{22} Magnitude < Angle	
1	0.25	$\underline{/6}$	9.1	$\underline{/-4}$	0.013	$\underline{/-167.1}$	0.19	$\underline{/84}$
10	0.18	$\underline{/-44}$	6.9	$\underline{/-74}$	0.024	$\underline{/178}$	0.64	$\underline{/-3}$
20	0.20	$\underline{/10}$	6.8	$\underline{/-134}$	0.051	$\underline{/128}$	0.77	$\underline{/-87}$
30	0.58	$\underline{/-39}$	6.0	$\underline{/154}$	0.048	$\underline{/45}$	0.84	$\underline{/174}$
40	0.70	$\underline{/-108}$	4.5	$\underline{/76}$	0.026	$\underline{/-120}$	0.94	$\underline{/90}$
50	0.44	$\underline{/-13}$	2.4	$\underline{/-57}$	0.073	$\underline{/25}$	0.62	$\underline{/75}$

Note: Measured in a 50-Ω system with a Motorola MRF 454 rf power amplifier under 5-A total bias.

5. Load impedances that fall within the shaded regions shown may also cause oscillations. The filter in Fig. 2b prevents the power amplifier from seeing any of the undesirable impedances, except within the 14-MHz passband.





6. A plot of driver-amplifier output impedance shows that the driver never presents to the power amplifier an impedance that causes instability.

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CIRCLE NO. 29

$$r_{11} = 4.38 \angle 114,$$

and the radius is:

$$P_{11} = 5.01.$$

Expression 4 then reduces to +1.5. This positive value indicates that the stable region for the input impedance lies inside its stability circle.

The Smith Charts in Figs. 4 and 5 show the results of the stability analysis, and Fig. 6 shows s_{22} of the driver, all in terms of reflection coefficients. The plot of stable and unstable regions on Fig. 4 is extrapolated from individual stability circles obtained from the calculations. Stability information for all frequencies and source impedances is plotted in this way. The power amplifier could oscillate if the source impedance fell inside the shaded areas.

The driver-output impedance in Fig. 6 presents an output impedance to the power amplifier that never falls within the unstable regions outlined in Fig. 4. Thus, at 4 MHz, s_{22} of the driver falls inside a shaded region. But it is stable since this shaded region is unstable for only a limited spectrum, 20 to 30 MHz.

In general, the amplifier becomes unstable about the two-to-one VSWR circle; so the driver output impedance must be controlled carefully. Together, the output-stability circles (Fig. 5) and the swept-frequency response (Fig. 3) point out the cause of the oscillation: At 30 MHz, the low-pass filter (Fig. 3) presents an impedance that is inside the 30-MHz instability circle (Fig. 5).

The solution requires a low-pass filter, with no out-of-passband responses falling inside the unstable regions at the frequencies indicated. The filter can present a short at 2 or 20 MHz, but not at 30 MHz. The out-of-passband response of a filter does not change with load since s_{12} equals zero. Therefore, this amplifier can be made almost unconditionally stable with a proper filter. Since a filter is transparent within the passband, the only additional loss would improve the 15-MHz stable operating range.

Fig. 2b shows a low-pass filter that meets all of the requirements. The new filter's topology differs radically from that of the first filter. It uses a choke input and output, rather thn a capacitive section. The topology change may not be necessary. As an alternative approach the break frequency or the number of poles might be changed. Still the filter in Fig. 2b does the job. Its swept-frequency response is confined to stable regions and, more importantly, the amplifier is stable even in the face of reactive loads.□

How useful?	**Circle No.**
Immediate design application	553
Within the next year	554
Not applicable	555

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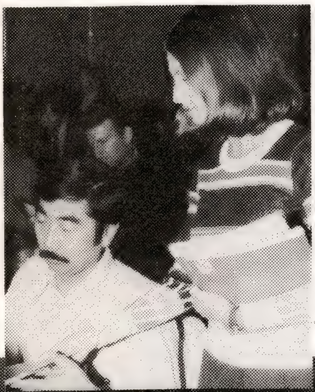

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MONDAY/LINEAR I

Three New Linear Families. New video SOS a/d flash converters, CA3179 1.3-GHz prescaler, divide-by-4 prescaler and precision BIMOS op amps are introduced. Hal Wittlinger, RCA, Somerville, N.J.

ICL7650 Glitchless Chopper-Stabilized Amplifier. Offers low offset voltage and exceptionally low input bias current at a very attractive price. Skip Osgood, Intersil, Cupertino, CA.

Am6300 Power-Supply-Control Subsystem. Computer-controlled, power-supply controller for sophisticated power-supply systems. Brian Gillings, Advanced Micro Devices, Sunnyvale, CA.

National's New Developments. A look at new low-power references, high-power regulators, and precision op amps coming from National Semiconductor.

DG211 4-Channel Switch. Fits a variety of low-cost applications. Jerry Mandel, Tom Cate. Siliconix, Santa Clara, CA.

CMOS Voltage Regulators, References and Voltage Detectors. Micropower devices covered include two-terminal voltage references, positive and negative programmable regulators and over-and-under voltage detectors. Jerry Zis, Intersil, Cupertino, CA.

New Voltage/Frequency Converter Techniques. New techniques lead to 18-bit a/d conversion with 1 ppm/°C gain stability. A 1.3-V (single-cell) supply circuit is also discussed. Bob Pease, National Semiconductor, Santa Clara, CA.

Analog/Digital LSI Design With I^2L Gate Arrays. A cost-effective approach. Bill O'Neil, Exar, Sunnyvale, CA.

RM4200 Analog Multiplier. Applications for a precision monolithic multiplier/divider are covered. Jim Schmoock, Raytheon Semiconductor, Mountain View, CA.

TUESDAY/LINEAR II

The HI5900 and HI5712: A Complete Microprocessor-Compatible System. An analog signal-processing front end and a 12-bit a/d converter form a high-speed, high-performance data-acquisition system. Al Morton and Rich Antalik, Harris Semiconductor, Melbourne, FL.

New Texas Instruments' Op Amps and Interface Circuits. Discusses single-supply, n-channel, FET-input op amps, comparators, new EIA RS-422 line circuits and 3-A peripheral drivers. Dale Pippenger, Texas Instruments, Dallas, TX.

BUF-03: Industry's Fastest Voltage-Follower Amplifier. Boasts a 300-V/μs slew rate and 55-MHz bandwidth. Two applications are described. With an OP-16, it forms a current booster capable of driving heavy capacitive loads; with a 500-pF holding capacitor, it functions as a fast sample-and-hold amplifier. Shelby Givens, Precision Monolithics, Santa Clara, CA.

9708 8-Bit, 6-Channel A/D Converter and 9706 12-Bit 8-Channel D/A Converter. Use in microprocessor-based control systems described. John Conover, Fairchild Semiconductor, Mountain View, CA.

OP-220 Dual Micro-Power Op Amp. Industry's first low-power, high-precision dual op amp. Lowest input offset voltage, lowest bias current over temperature, and lowest input-offset-voltage temperature coefficient of any dual amplifier. CMVR includes ground which makes this device ideal for light, compact battery-operated instrumentation. Tom Schwartz, Precision Monolithics, Santa Clara, CA.

Microprocessor-Compatible Conversion ICs. Discussion of new a/d and d/a converters and sample-and-hold amplifiers. Steve Sockolov and Phil Marcoux. Signetics, Sunnyvale, CA.

New Motorola Industrial ICs. Describes IC drive system for stepper motors. Speakers to be announced. Motorola, Phoenix, AZ.

Monolithic ICs for FSK Modem Design. A two-chip FSK modem design. Joel Silverman, Exar, Sunnyvale, CA.

Power Interface Circuits. Introduces UDN-2949Z bipolar half-bridge motor driver and UCN-4202A stepper motor translator/driver. Paul Emerald, Sprague, Worcester, MA.

WEDNESDAY/MICROPROCESSORS I

Microcomputers From Intel in the 1980s. Integrating software into silicon; simplifying the interface to the user. Dane Elliot, Intel, Santa Clara, CA.

Introduction to Signal-Processor ICs. Features, architecture and instruction set described. Bob Holm, Intel, Santa Clara, CA.

The Intel 2920 Signal Processor. A discussion of 2920 applications. Bob Holm, Intel, Santa Clara, CA.

Microcontrollers: System-Designed

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Microcomputers. New signal processors and microprocessors. Dick Barck, American Microsystems, Cupertino, CA. Santa Clara, CA.

The S68045 CRT controller. Reduces CRT system cost design. Frank Toth, American Microsystems, Santa Clara, CA.

Motorola's New Family of CMOS Microprocessors. Five new CMOS ICs with a/d converter, RAM, ROM and EPROM on the chips. Jim Farrell, Motorola, Austin, TX.

Fast Error Detection and Correction for Memory Systems. Use of AM2960 16-bit EDC IC is described. John Mick, Advanced Micro Devices, Sunnyvale, CA.

MB1412A 8-bit-slice ECC IC. Use of error-checking-and-correction chip described. Alan Heimlich, Fujitsu Microelectronics, Sunnyvale, CA.

THURSDAY/MICROPROCESSOR II

The NS16000 Family: Support for Software Modularity. NS16000 architecture eliminates the need to modify machine code. Linking process illustrated. Brian Marley, National Semiconductor, Santa Clara, CA.

Software Solutions for Board Applications. The software exists to design your next microprocessor-based board product. Joanne Pearson, Intel, Santa Clara, CA.

Transparent Addressing Resolves Memory Contention in Terminal Application. SY6545 allows addressing of screen-refresh memory transparent to processor to improve overall design efficiency. Conrad Boisvert, Synertek, Santa Clara, CA.

Mask-Programmable Low-Power-Schottky Gate Array. Shrinking system design. Cliff Vaughan, Raytheon Semiconductor, Mountain View, CA.

2653 Polynomial Generator Checker. Performs block/check character and parity generation, checking, single-character detection and two-character sequence detection. Alex Goldberger, Signetics, Sunnyvale, CA.

Bipolar Arithmetic Devices Support New MOS Microprocessor. Multiplier/divider enhances performance of otherwise slow MOS microprocessor. Shlomo Waser, Monolithic Memories, Sunnyvale, CA.

NE5560 Switched-Mode Power-Supply Control Circuit. For flyback forward or double forward (push-pull) outputs, provides all control interfacing needed. Norm Matzen, Signetics, Sunnyvale, CA.

Leadless Carrier Memory Arrays. Describes applications techniques. Charles Hochstedler and Jeff Wilkinson, Harris Semiconductor, Melbourne, FL.

FRIDAY/MICROPROCESSOR III

Single-Chip Fairchild Microcomputers. Describes applications for currently available F3870 devices and explores the use of tomorrow's multiple-function-on-a chip ICs. Jim Lang, Fairchild Semiconductor, So. San Jose, CA.

NSC800 In Low-Power Systems. Uses new high-density CMOS process called P^2CMOS. An 8-bit CPU and supporting components are covered. Keith Winter, National Semiconductor, Santa Clara, CA.

Design and Use of Mostek PROM Programming Unit. Applies MK3873 single-chip microcomputer. Don Folkes, Mostek, Carrollton, TX.

The CONCEPT-48 Development Tool. Single-board system for 80C48 family. Gopal Ramachandran, Intersil, Cupertino, CA.

Z80 As a Versatile Communications Device. Z80 FIO as used in BiSync, HDLC, and SDLC communications protocols. James Booth, Mostek, Carrollton, TX.

PALs Replace Random Logic in Microprocessor Designs. Use of PAL series 20 to replace 7400 series MSI/LSI devices in microprocessor applications. Saeed Kahmi, Monolithic Memories, Sunnyvale, CA.

NS16000 Supports Virtual Memory. Virtual memory, a mainframe concept in the past, is applicable to microprocessor-based designs thanks to the 16000 microprocessor. Su Bhash Dal, National Semiconductor, Santa Clara, CA.

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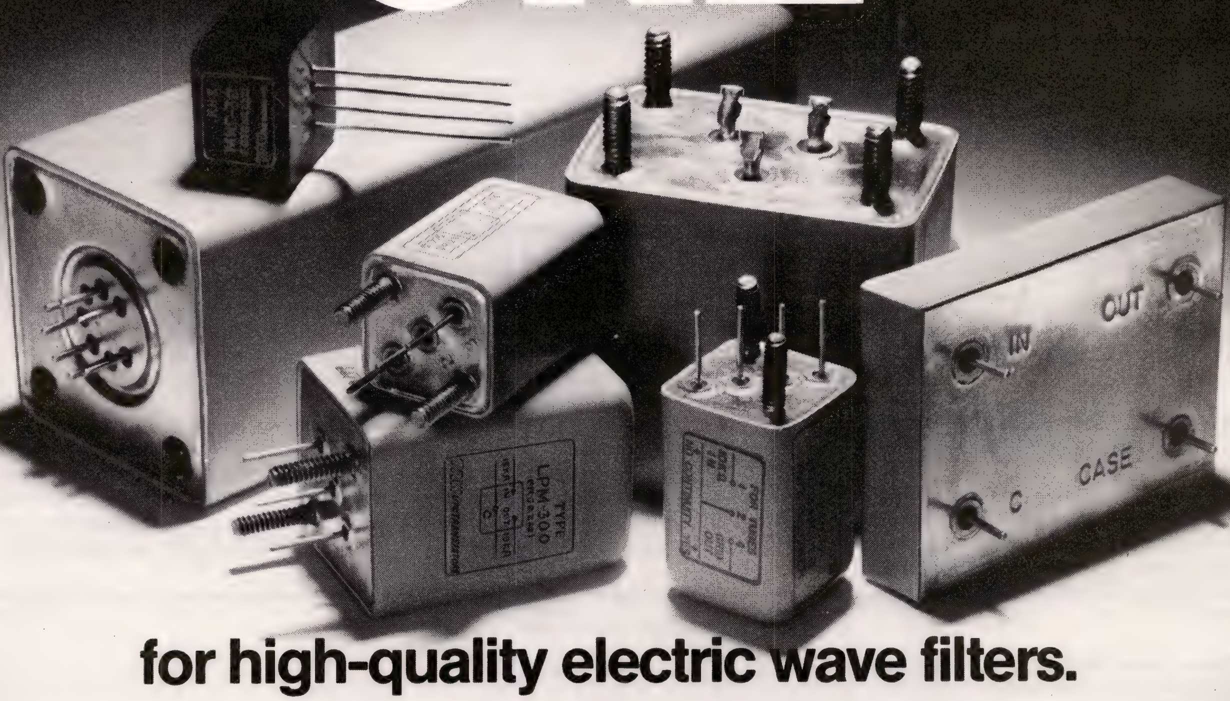

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CIRCLE NO. 54

Single or multiple chip sets implement the complex functions of a video terminal—programmable I/O and counters, keyboard scanner and encoder, baud-rate generator, memory and video timer and controller.

Video terminal strips down to 26 MOS/LSI chips

Just 26 chips tailor a versatile smart video terminal comprising a character generator, programmable I/O ports, programmable event counters, keyboard scanner and encoder, USART, baud-rate generator, memory, video timer and controller, and display-attributes controller (Fig. 1). MOS/LSI technology puts these complex functional blocks onto single or multiple-chip sets, giving the user more flexibility and more features to work with. MOS/LSI technology also enhances the efficiency of the microprocessor which is the driving force behind the terminal.

The user can manipulate screen characters simply by instructing the microprocessor to move characters from one memory location to another. The user instructions control the video through a CRT 5037 Video-Timer-Controller chip (VTAC) and a character-generator attributes chip (called a VDAC for Video Display-Controller).[1]

The VTAC is a flexible, programmable CRT controller chip that generates all the timing signals to run a CRT video monitor. The VTAC produces horizontal sync, vertical sync and blanking for monitors with separate direct drives and TTL-compatible inputs; the composite sync output is combined with video to produce a signal that can drive most rf modulators. Therefore, a standard TV can be used as a monitor.

Mask-programmable options

The VDAC provides a variety of Mask-programmable options to format the cursor as an underline, blinking underline, reverse video or blinking reverse video. The user can select the character and cursor blink rates and other characteristics of display modes. The VDAC's ROM contains a custom character font to format characters in a dot matrix as large as 7 × 11. The user can define backfill dots and extra raster scans for each data row. Thus, a variety of intercharacter and interrow spacings are possible.

The VTAC communicates with the VDAC (which generates the video) through the video RAM. The 2 k × 8 static video RAM is a two-port memory; therefore, memory addresses can be sourced from either the 8085 μP or the VTAC. The RAM capacity allows the screen to be formatted with up to 2048 characters. This smart terminal is based on 14 data rows of 80 characters. For more characters, the user can reinitialize the VTAC or use a faster crystal or add more video RAM and so boost the horizontal scan rate of the monitor. If the monitor is run in an interlace format, the number of data rows on the screen is effectively doubled. The screen formats made possible by the VTAC are limited only by the size of the video RAM (see Table 1).

After the VTAC addresses the video RAM, ASCII character data are sent to the VDAC. The VDAC then serializes the contents of the ROM location and shifts them out to the video driving circuitry at speeds up to 10 MHz.

The microprocessor responds much faster than any human could to instructions to move data. However, its very speed creates problems. The monitor has to be refreshed constantly with information to produce enough dot patterns for a stable video presentation. Thus, the VTAC must continually address the video RAM and send information to the VDAC. The need for constant refreshing of the screen puts the VTAC in conflict with the μP over the use of the video RAM.

The μP yields to the VTAC

The solution to memory contention depends on the user's requirements. One solution is to make the μP yield priority to the VTAC when the VTAC is transmitting displayable information to the monitor. When the 8085 μP addresses an area of video RAM, it is put into a wait state by lowering its READY line

Mort Herman, Senior Systems Engineer
Standard Microsystems Corp.
35 Marcus Blvd., Hauppauge, NY 11787

until the next retrace cycle.

The hardware needed to implement this contention scheme consists of a single OR-gate tried to the μP's READY line. A flip-flop synchronizes the READY signal. This operation extends the memory cycle until the next horizontal retrace period. Since the screen is blanked during the horizontal retrace, the μP can conclude its memory cycle without causing the CRT to flash. The μP has limited access to the video RAM and the VTAC has unlimited access. A Clear-Screen command activates a video-blank signal that clears the screen in 25 ms.

The microprocessor's throughput is reduced since some memory cycles can be extended to 50 or 60 μs. If a move of 2000 characters in the video RAM is required, each access to this RAM will be about 50 μs or one access per scan line. However, access to the main system memory is maintained at the full microprocessor speed.

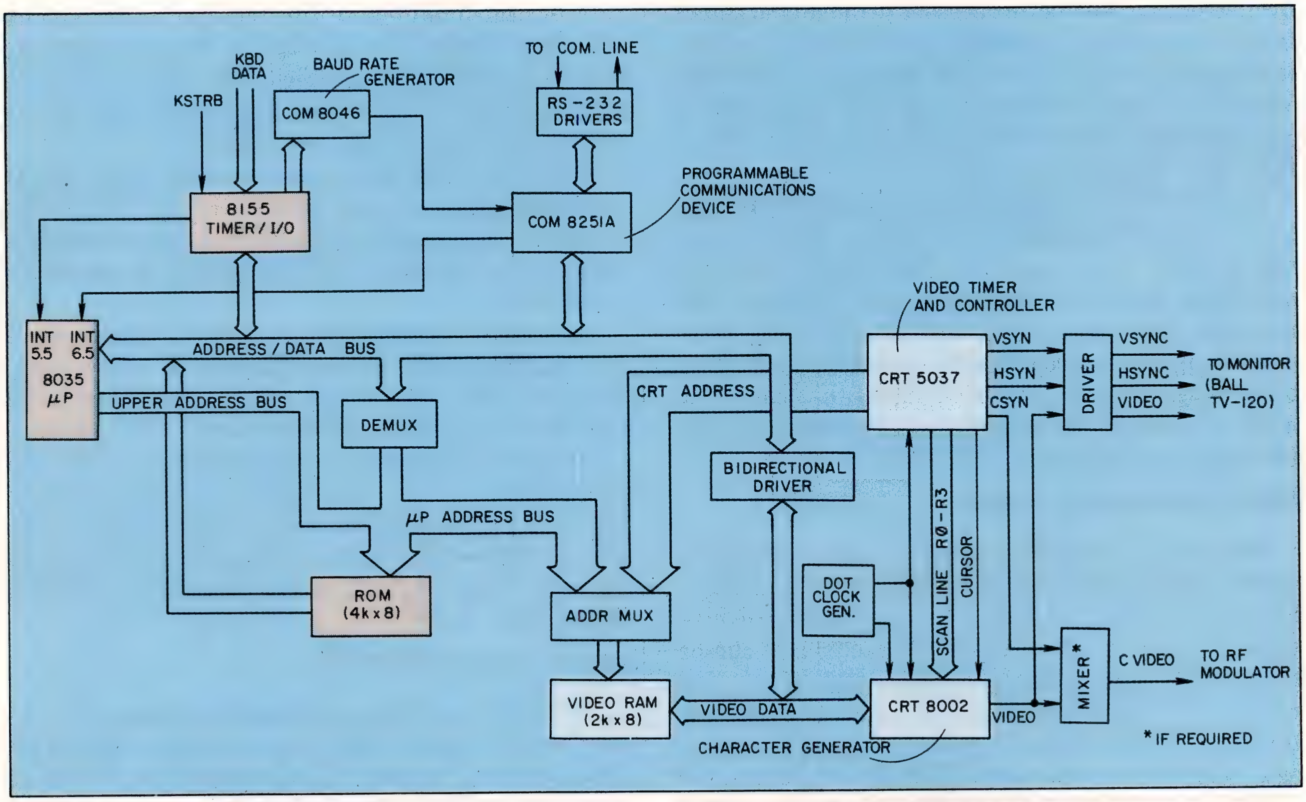
This approach to memory contention must be modified to display high-speed communications data. The information is displayed at the high baud data rate by using a communications buffer that takes 128 bytes of RAM.

The RAM for the communications buffer is contained on the 8155 interfacing chip, which connects the microprocessor to the keyboard. This chip contains 256 bytes of RAM, a programmable timer, and two I/O ports. The RAM is sufficient for the entire system (except the video RAM). It contains the stack communications buffer and certain software variables.

Software commands initialize the 8155. One of the chip's two ports is an input port that captures data upon the receipt of a strobe from a standard keyboard. The chip then generates an interrupt to the μP (RST 5.5), indicating that the keyboard has entered a new character.

The keyboard is scanned by a keyboard-encoder/scanner/debouncer chip (KR3600). When a key is depressed, the chip stops scanning and, after a brief debounce delay, reexamines the key. If the key is still depressed, the data are presented and strobed into the timer's input port. The "debounce" delay is defined by connecting an RC network to one pin of the keyboard encoder. Once the strobe is sent out, regular key scanning resumes.

The other port of the interfacing chip is an output port. The 8085 μP uses it to set certain conditions throughout the terminal. Five outputs select the communications baud rate by providing a 4-bit select code and a strobe to the programmable baud-rate generator (COM8046). The user can set the baud rate by entering it through the keyboard.



1. Memory contention in the terminal design is resolved by giving the VTAC priority in addressing the video RAM. When the μP addresses an area of video RAM at the same time, it is put into a wait state and its memory cycle is extended to the next horizontal retrace.

Table 1. Screen formats and associated horizontal-scan frequencies

Data rows	Characters per data row	Horizontal-scan frequency (kHz)
16	32	15.72
16	40	15.72
16	64	15.72
16	80	15.72
16	96	15.72
24	32	18.50
24	40	18.50
24	64	18.50
24	80	18.50
20	96	18.50

Table 2. Available baud rate and control codes

Baud rate	Enter following an ESC B
50	0
75	1
110	2
134.5	3
150	4
300	5
600	6
1200	7
1800	8
2000	9
2400	:
3600	;
4800	<
7200	=
9600	>
19200	?

The programmable baud-rate generator runs from a 5.0688-MHz crystal and has four binary inputs that allow sixteen baud rates, from 50 baud to 19.2 kbaud (Table 2). The fixed clock output of the baud-rate generator provides clocking for the 8085 μP and for a programmable communication device (USART), COM8251A, that supports half or full-duplex, RS-232C, asynchronous, ASCII communications.

Partitioning saves on chips

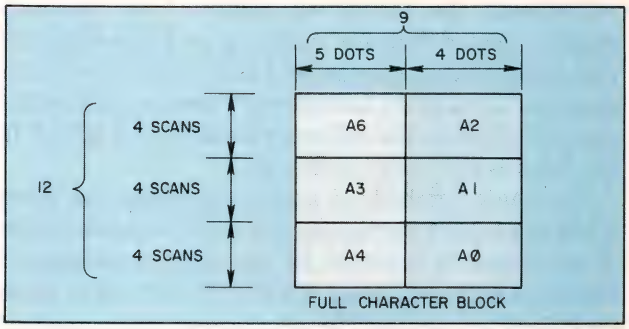
Memory address space has been partioned for minimum chip count in the decoding circuitry (Table 3). The software for this terminal centers around two interrupts, RST 5.5 and RST 6.5 on the μP. RST 5.5 is generated whenever new keyboard data are strobed into the interfacing chip.

If the terminal is in the local mode and the appropriate character key on the keyboard is depressed, the μP receives an interrupt from the interfacing chip, and the ASCII data are written into a memory location within video RAM by the μP. The memory location is determined by the contents of two registers in the VTAC. With these registers, the VTAC keeps track of the cursor. After characters are entered, the cursor position is updated. For functional inputs, the user must press the ESC key. This key enters an escape-sequence mode which allows the μP to interpret ASCII inputs as control functions, instead of a displayable characters. The addition of a single keystroke thereby gives the software considerable flexibility. Some of the features of this terminal include character insert/delete, line insert/delete and partial line/page erase. A description of all control functions that are needed is given in Table 4.

If the terminal is on-line for half-duplex operation, the key entry initiates the appropriate action within the terminal and is also transmitted via the USART.

Table 3. Memory address space

Memory address	Function
0-7FFF	Present and future programs
8000-80FF	General-purpose RAM
9000	I/O register within the COM8251A for transmit or receive
9001	Mode and command instruction of the COM 8251A
A000	Horizontal line count
A001	Interlace bit, HSYNC front porch and width
A002	Scans/data row, characters/data row
A003	Skew bits, data rows/frame
A004	Scan lines/frame
A005	Vertical data start
A006	Last data row displayed
A008 CRT 5037	Vertical cursor read
A009	Horizontal cursor read
A00A	Reset command address
A00B	Up-scroll command address
A00C	Horizontal cursor write address
A00D	Vertical cursor write address
A00E	Start command
C000-C7FF	Video RAM memory



2. The wide graphics mode is entered with an attribute character. The VDAC interprets the attribute and generates the video. The character block for the wide graphics mode is divided into six boxes. The ASCII bit 6 and bits 4-0 define the on/off status of the six boxes.

If the terminal is set up for full-duplex, the key entry is not directly decoded by the terminal software, but is transmitted via the USART. After delay, the host CPU echoes back the transmitted entry, invoking RST 6.5. The terminal responds to the interrupt by allowing the software to decode the message as if it were an off-line key entry. The USART raises the RST 6.5 interrupt each time it receives a character. The character is then entered into video RAM.

The VDAC permits four display modes. An internal mode is generally used to display normal ASCII characters from the on-chip ROM. The external mode displays special characters not found in the on-chip ROM. The remaining two modes are a thin graphics mode (not used in this design) and a wide graphics mode. The modes differ in the way that ASCII characters are interpreted and the video is generated.

The wide graphics mode is entered via an attribute character. The character block is divided into six smaller blocks (Fig. 2). The ASCII bit 6 and bits 4-0 define the on/off status of the six-block graphics. Fig. 2 shows all 64 graphic combinations. The wide graphics mode can generate forms, bar charts and histograms.

For full utilization of the VDAC, the attributes associated with each character must be specified—blinking or underlined or in a reversed video field or any combination of the three. The two ways of generating attributes are embedded or invisible. In the former, attributes are inserted or embedded within the displayable character stream. In this design, all subsequent displayable characters exhibit the attributes defined by the last attribute character. One character position is used (normally a space between words) each time an "embedded attribute" is used.

Generating invisible attributes requires a wider memory. Each character has attribute bits appended to it. Attributes can change with every character, with no loss in the number of displayable positions.

Although the VDAC can handle video memory greater than 8 bits for enabling and disabling invisible attributes, the cost and chip count would both increase. Data entry to a memory greater than 8 bits also complicates the software design; an 8-bit μP is for 8-bit wide video memories.

The use of embedded attributes keeps the video RAM at 8 bits. A particular attribute or combination of attributes is initiated by inserting a designated attribute byte into video RAM. All characters from that point on exhibit the attribute(s) until another attribute byte is encountered. The VDAC distinguishes an attribute byte from a displayable character because the most significant bit of an attribute byte is a logic ONE. The seven remaining bits define

Table 4. Keyboard control functions

Control key input	Function
ESC A	Toggle character add mode. Characters can be inserted at the cursor location and all characters to the right of the cursor are shifted to the right. This function operates on one line at a time.
ESC S	Character subtract. All characters to the right of the cursor are shifted to the left. The character at the cursor location is replaced by the character shifted into that position. This function operates on one line at a time.
ESC I	Line insert. All data rows at the cursor and below are dropped one data row, and a blank line is inserted at the cursor data row. The cursor is returned to the left margin.
ESC D	Line delete. All data rows below the cursor are moved up. A blank line is inserted at the last data row. The cursor is returned to the left margin.
ESC E	Partial line erase. The line in which the cursor appears is erased, starting at the character position of the cursor.
ESC C	Partial screen erase. The screen is erased, starting at the cursor position.
ESC G	Full screen erase. The entire screen is erased and the cursor is positioned to home.
ESC B	Set baud rate. The communication baud rate is set by entering one of 16 characters (see Table 2), following the ESC B.
ESC U	Toggle the underline attribute. This control code will start an underline field if the current character is not within an underline field; and it will end an underline field if the current character is in an underline field.
ESC R	Toggle the reverse video attribute. This control code will start a reverse video field if the current character is not within a reverse video field; and it will end a reverse video field if the current character is in a reverse video field.
ESC P	Toggle the blink attribute. This control code will start a blink field if the current character is not within a blink field; and it will end a blink field if the current character is in a blink field.
ESC W	Toggle the wide graphics mode. This control allows a video presentation in the form illustrated in Fig. 2. This control code will start a wide graphic field if the current character is not within a wide graphic field; and it will end a wide graphic field if the current character is in a wide graphic field.
ESC X	Set tab. Sets a tab stop at the current horizontal cursor position.
ESC Y	Clear tab. Clears the tab stop at the current horizontal cursor position.
ESC Z	Clear all tabs. Clears all tab stops.
ESC G	Set half-duplex mode. Sets the terminal to run in the half-duplex communications mode.
ESC F	Set full-duplex mode. Sets the terminal to run in the full-duplex communications mode.
ESC V	Display terminal status. This control allows the operator to view terminal status by having a status row appear on the CRT at the last data row position. Initiating another ESC V will restore the previously displayed data row to the CRT.
ESC N	Transmit partial page. Transmits all displayed characters up to the cursor position via the RS-232 communications port.

up to seven character attributes.

An attribute enable pin on the VDAC maintains the attributes internally. This pin is wired so that the VDAC's internal attribute latch is updated only during an attribute byte. Since each attribute occupies a location in video RAM, its associated display position on the screen must be blanked with the RETBL pin on the VDAC to prevent an erroneous display.

Under most conditions, embedded attributes are neatly displayed since they occur when the screen presentation would normally be blanked.

Software inserts an initial attribute byte in the first character position of each data row displayed on the monitor. Attributes will not wrap from row to row unless they are initiated by the operator. The software never positions the cursor over the first character in each row; data entry always begins at the second character position. The initial attribute byte can be changed by positioning the cursor at the second character position and entering an attribute character through the keyboard.

Providing an initial attribute in the first position of every data row allows a smooth left margin to be maintained. Each byte in video RAM in the range 80 to FF hex is used exclusively for attribute combinations. For displayable ASCII characters, 20 to 7F are used. The remaining 00 to 1F hex characters do not enter the video RAM, but are reserved for operator functions, like cursor movement commands.

The ultimate terminal

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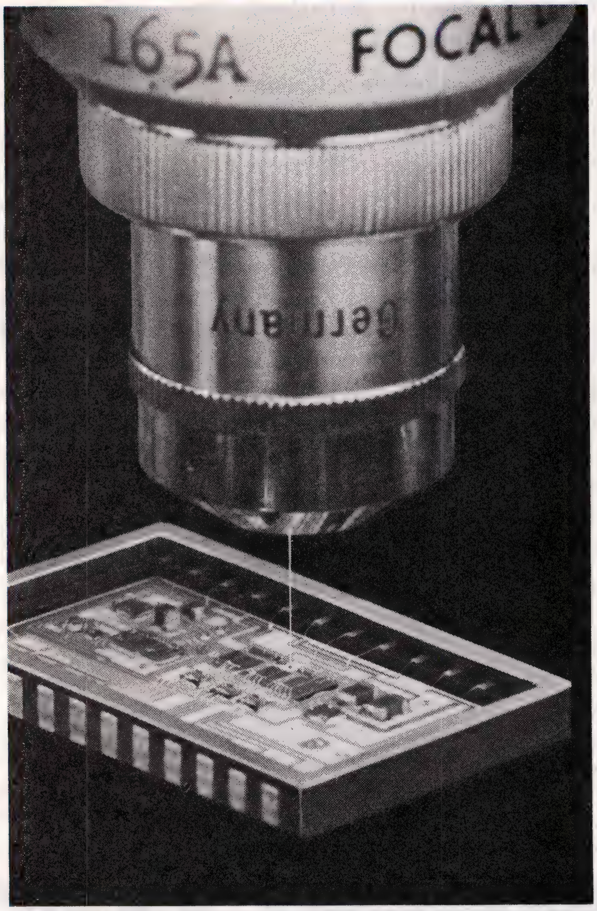

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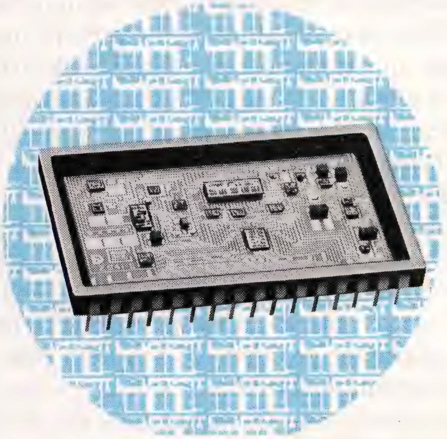

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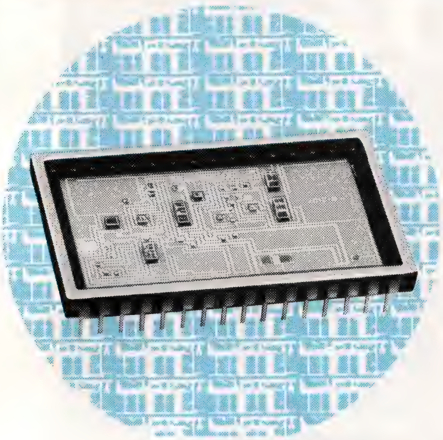

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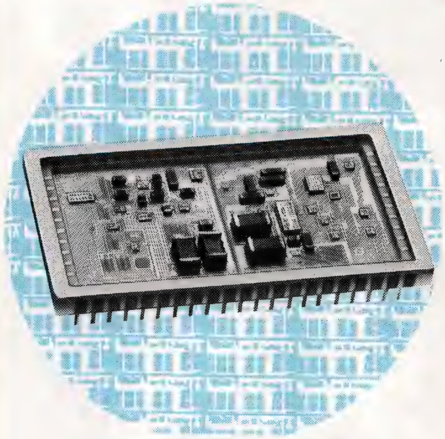

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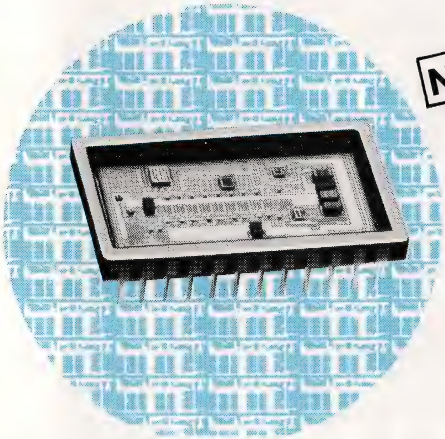

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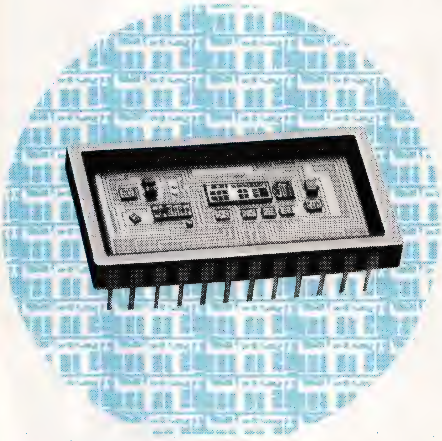

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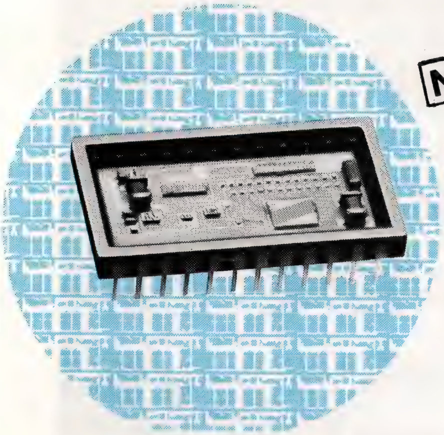

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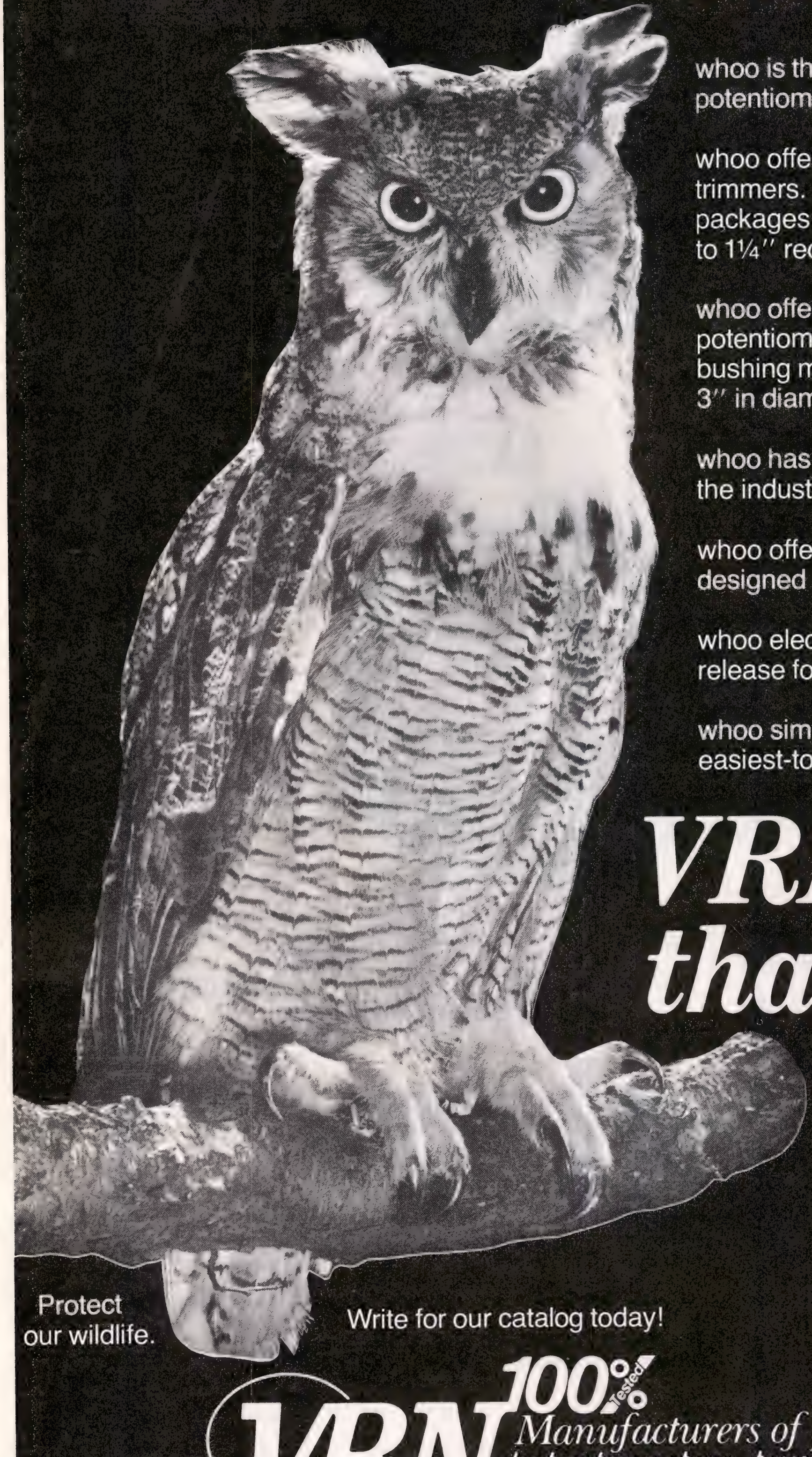

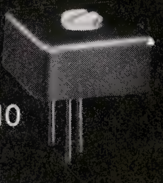

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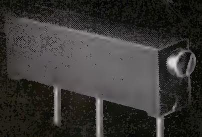

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Architecture for hi

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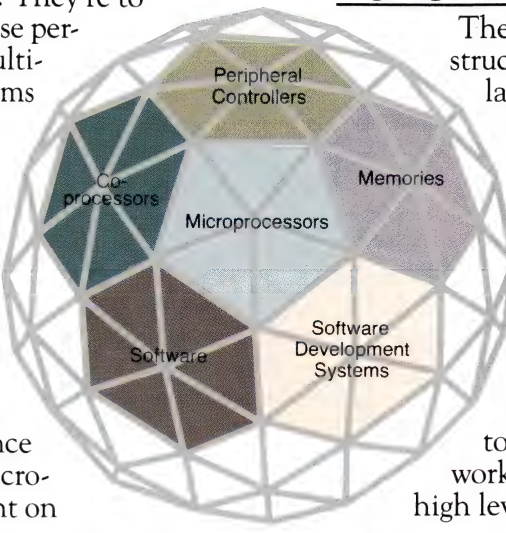

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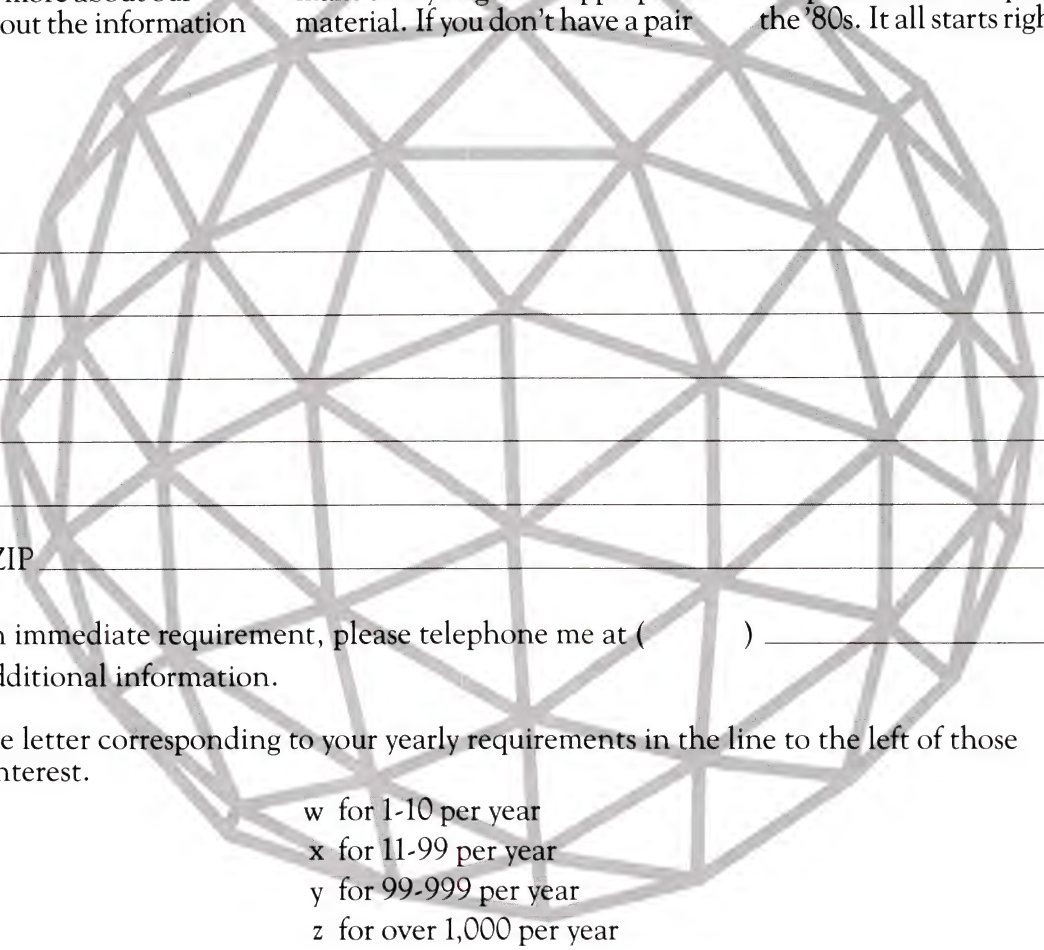

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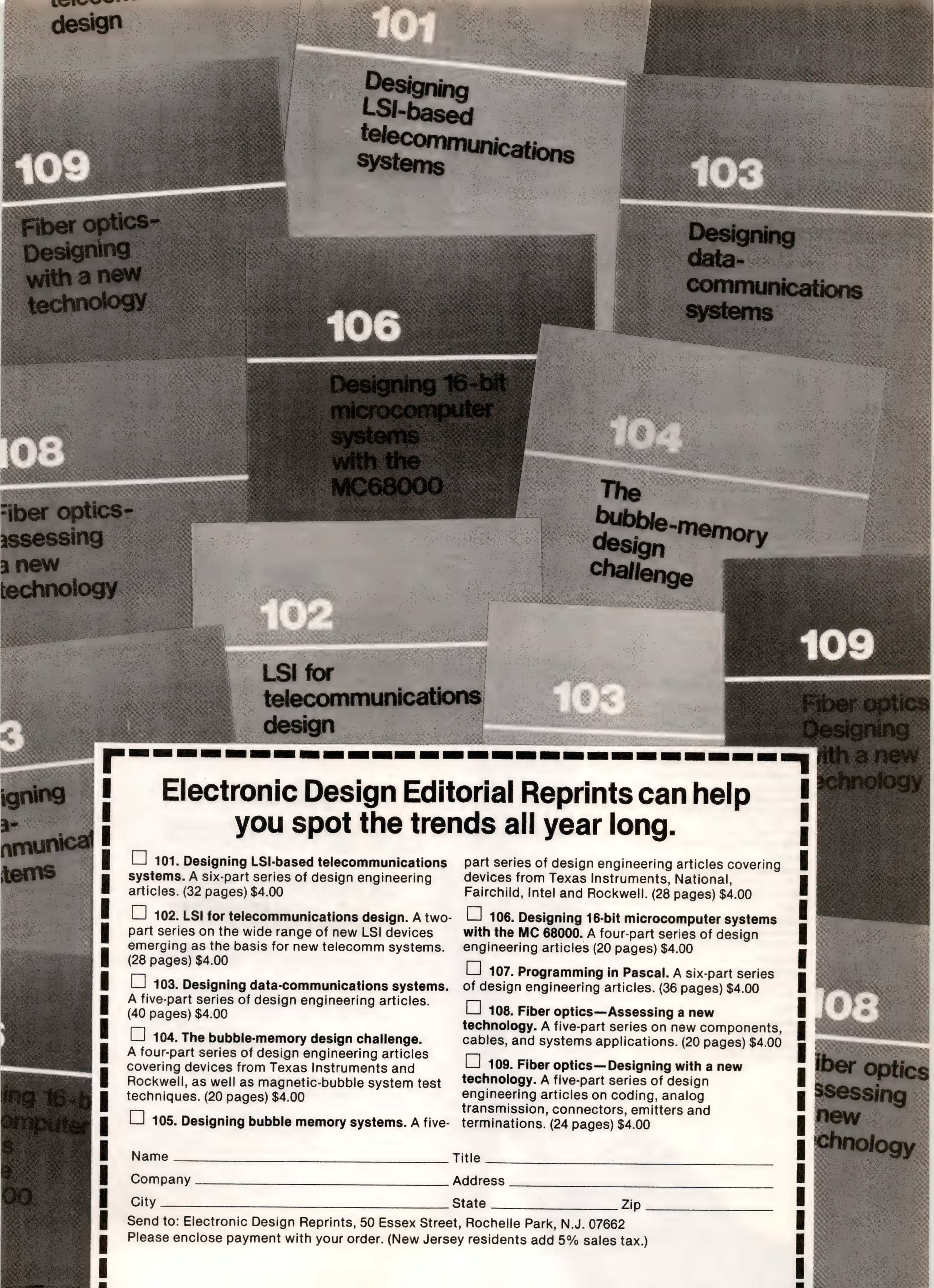
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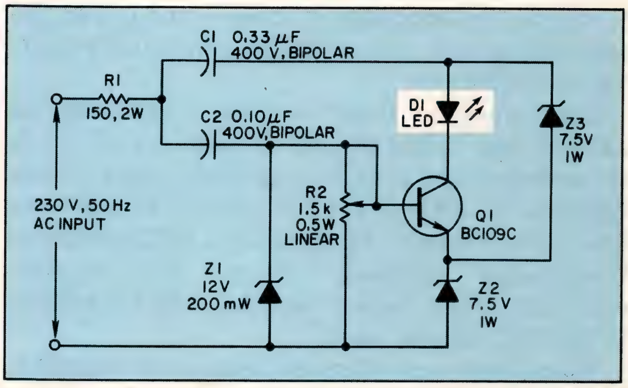
The ac line being monitored supplies the circuit's power through two voltage dividers (see Fig.). One of these dividers, formed by C_2 and R_2, makes the voltage across R_2 porportional to the ac input voltage. Potentiometer R_2 then produces the voltage sample that is fed to the base of transistor Q_1. Zener Z_1 limits any voltage spikes across R_2 occurring during positive ac half-cycles.

The second divider consists of C_1, Z_3 and Z_2. Z_2 and Z_3 are voltage-limiting during positive ac half-cycles and provide the collector dc supply to Q_1.

When the ac input exceeds the preset threshold (as determined by R_2 and the zener value of Z_2), Q_1 is forward-biased and the LED is lit. Samples of the monitored ac voltage are provided to Q_1 only during the positive ac half-cycles. During the negative half-cycles, all the ports of Q_1 are short-circuited by the three zeners, because of forward conduction. Even though the LED conducts for a partial cycle, its glow appears to be continuous.

Zener Z_2 alone determines the reference stability. The values of Z_1 and Z_3 are less critical. However, Z_1 limiting should be higher than the maximum settable value of the instantaneous peak voltage across R_2; Z_3 limiting should be higher than the combined forward voltage drop of the LED and the maximum expected collector-emitter drop across Q_1.



The switching threshold for this ac voltage monitor is preset using R_2. The LED turns on (off) when the voltage is above (below) the threshold.

The circuit may be adapted to monitor a 110-V, 60-Hz input by doubling the values of C_1 and C_2. A pnp transistor may be used for Q_1 by reversing the connection of the zeners and the LED.

D. Venkatasubbiah, Assistant Director, Telecommunication Research Centre, Khurshid Lal Bhavan, Janpath, New Delhi-110001, India.

CIRCLE NO. 311

Improve programmed-I/O rates without complex DMA

Complex direct-memory-access (DMA) schemes are not the only way to adapt much faster programmed-I/O data rates to systems designed around "slow" microprocessors. Simply alter the processor's program flow based on the Data Available (DAV) and Done (DONE) signals that are provided by a typical system's floppy-disk control (FDC) chip.

Faster programmed-I/O data rates are required by peripherals that have become very complex and intelligent—for example, a double-density floppy-disk system (including disk-controller chips). This system requires a processor to handle a byte of data every 16 µs. For instance, to read a disk sector, the processor must do five things for each byte in the sector:

1. Loop until a byte is available from the FDC chip
2. Read the byte
3. Store the byte in memory
4. Increment the memory pointer
5. Check for end-of-sector and repeat.

If the system is designed around a 500-ns-clock 8080, these operations normally cannot be performed in 16 µs. For single-density floppy-disk systems, the processor's Wait line may be used to handle item 1.

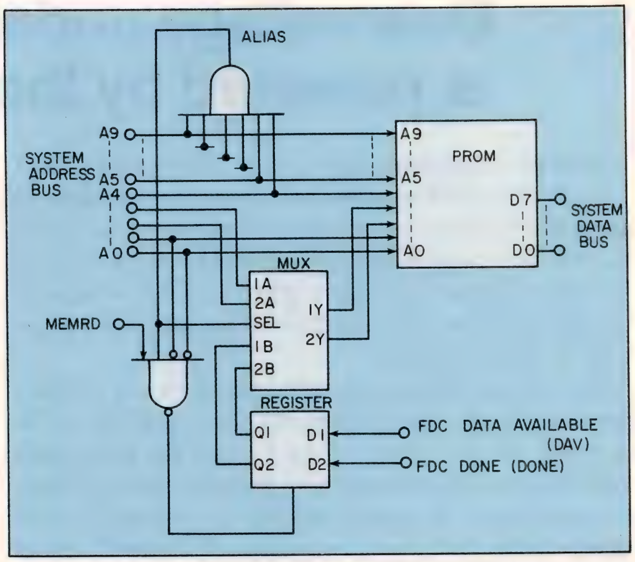
However, this solution is unacceptable for Z80 systems that rely on internal refresh.

But altering the processor's program flow based on the DAV and DONE signals from the FDC chip (Fig. 1) relieves the processor of items 1 and 5. For this approach to work, part of the program must execute out of PROM.

The connection shown in Fig. 1 will alias the address lines (when the last 16 locations of PROM are accessed) and execute a particular block of code based on the state of the FDC chip's DAV and DONE lines. A special code (Fig. 2) put into PROM produces "read sector" operation. (Assume that the disk-controller chip is memory-mapped with the address in the DE register pair).

When the processor has initiated a read operation, the program should jump to X3F0 and begin executing the JMP $ instruction. As long as DAV and DONE are both zero, this instruction will be executed repetitively. When DAV and/or DONE change, their new state will be clocked into register R after JMP op code is fetched. The address fetched will be the one associated with the new signal states.

This technique reduces processor time per byte to 14.5 μs, 1.5 μs less than the requirement. It also preserves internal refresh on the Z80, is easily implemented with minimum hardware, and can be applied in many other situations where faster programmed-I/O rates are needed.



1. **Faster programmed I/O data rates are obtained by altering the system microprocessor's program flow. This connection will alias the address lines and execute a particular block of code based on the state of the floppy-disk control chip's DAV and DONE lines.**

Jay Bowden, Electrical Engineer, SAI, 4030 Sorrento Valley Blvd., San Diego, CA 92121.

CIRCLE NO. 312

FDC signals DONE	DAV	Location in PROM	Code		Cycles	Microseconds
		X3FD	Read:	LDAX D	7	3½
		X3FE		MOV M,A	7	3½
		X3FF		INX H	5	2½
		X3F0		JMP $	10	5
0	0	X3F1		F0		
		X3F2		X3		
		X3F3		NOP		
		X3F4		JMP READ	10	5
0	1	X3F5		FD		
		X3F6		X3		
		X3F7		NOP		
		X3F8		JMP DONE	10	5
1	0	X3F9		XX		
		X3FA		XX		
		X3FB		NOP		
1	1	X3FC		JMP DONE	10	5
		X3FD		XX		
		X3FE		XX		
		X3FF		NOP		

2. **For the circuit of Fig. 1 to operate successfully, this code must be put into (and execute out of) PROM to produce "read sector" operation.**

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UNITED STATES **Spectrol Electronics Corporation** P.O. Box 1220, City of Industry, Calif. 91749, U.S.A. • (213) 964-6565 • TWX (910) 584-1314
UNITED KINGDOM **Spectrol Reliance Ltd.** Drakes Way, Swindon, Wiltshire, England • Swindon 21351 • TELEX: 44692
ITALY **SP Elettronica SpA** Via Carlo Pisacane 7, 20016 Pero (Milan) Italy • 35 30 241 • TELEX: 330091
GERMANY **Spectrol Electronics GmbH** Oberauerstrasse 15, 8000 Munich 70 West Germany • (089) 7145096 • TELEX: 52/3014

CIRCLE NO. 44

Single optically-isolated driver controls inverse-parallel SCRs

The bilateral switching action of the MOC3031 optically-isolated triac driver can alternately trigger two SCRs in an inverse-parallel connection. Operating with gate-current steering diodes (see Fig.), the MOC3031 offers 7500 V ac isolation, low parts count, hard-firing of the triacs and built-in zero-cross triggering—all at relatively low cost.

Gate-current steering diodes D_1 and D_2 may be any type that can handle a few hundred milliamps. R_1 provides current limiting and prevents surges from exceeding the peak current capabilities of the MOC3031 output. Since the triac driver is inhibited about 25 V, about 33 Ω should provide suitable protection.

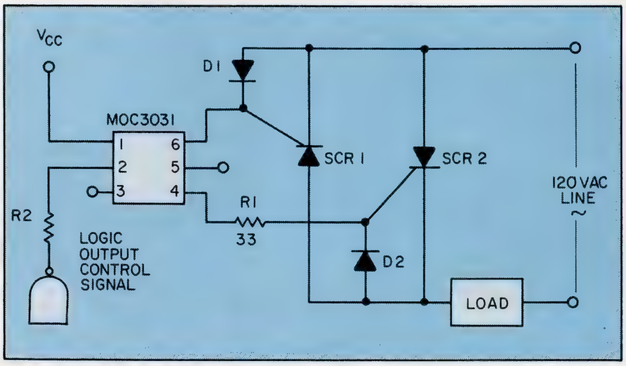
Usually, the SCR on-voltage is low, so the voltage across the MOC3031 output can be clamped below 0.7 V—the level required to sustain regeneration. As a result, the MOC3031 is on only during the very brief period needed to fire an SCR. The triac driver sees a very short duty cycle and exhibits negligible temperature rise above ambient, even when controlling very large SCRs.

Transients on the 120 V ac line appear to the MOC3031 as static (rather than commutating) dv/dt. The triac driver's static dv/dt capability is typically $>100\ \text{V}/\mu\text{s}$, allowing power control in severe environments or with largely inductive loads.

Since the MOC3031 requires just 15-mA LED drive, most logic outputs can supply this current and control the high-performance ac load directly. The MOC3031 output current is sufficient to drive large SCRs without any other power source than the 120 V ac line.

David M. Gilbert, Product Manager, Optoelectronics, Motorola Semiconductor Group, 5005 E. McDowell Rd., Phoenix, AZ 85008.

CIRCLE NO. 313



The MOC3031 optically-isolated triac driver mates digital logic levels with 120-V ac power control circuits. Most logic outputs can drive the MOC3031 directly since its internal LED draws just 15 mA.

Winner for February 1, 1980
"Triac Senses ac Half-cycle Polarity; Determines Direction of Motor Rotation"
David McCracken, Principal Engineer
Thera Institute
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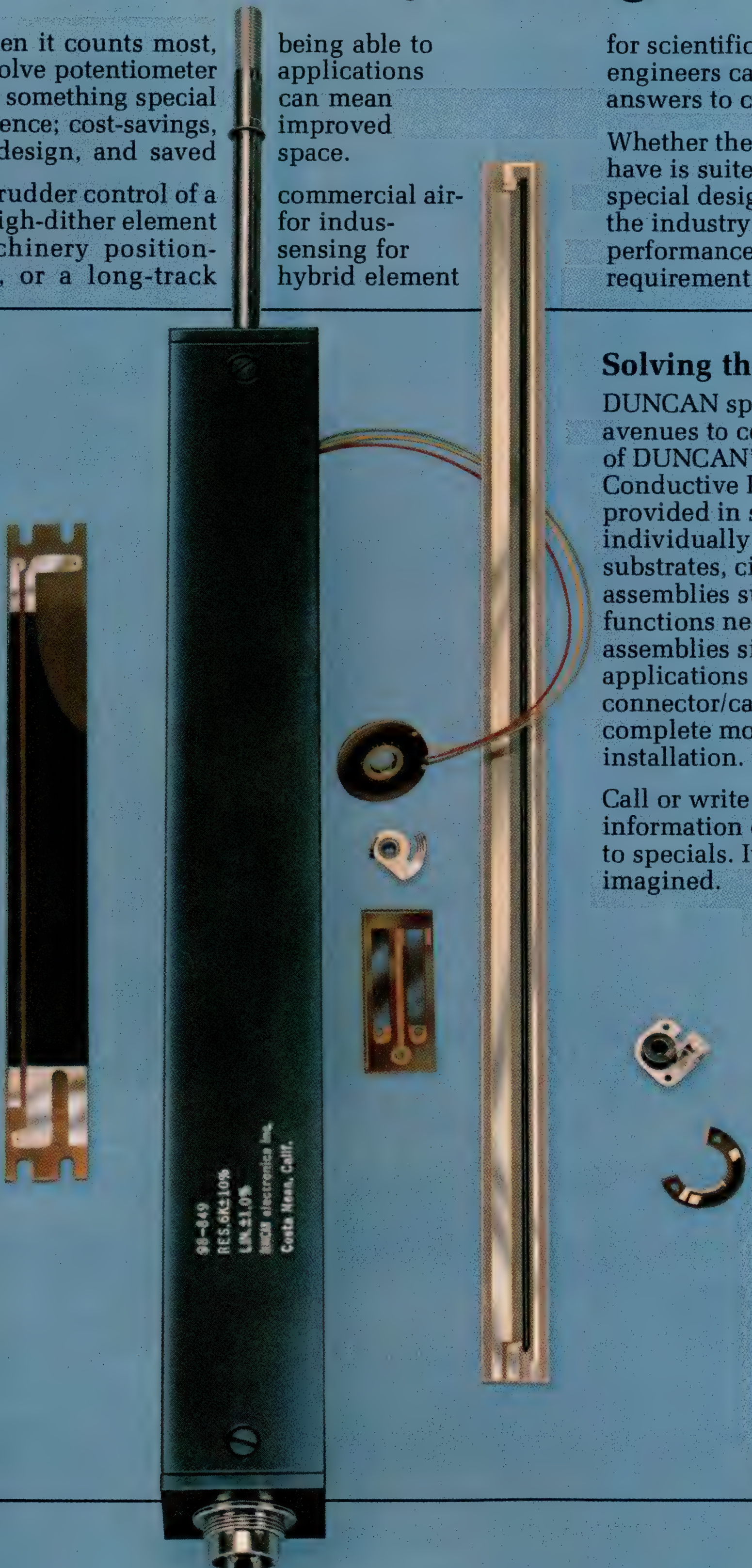
SPECIAL POTENTIOMETER CAPABILITIES:

Special, cost-efficient systems controls can be less than you might have imagined.

Now, when it counts most, being able to quickly solve potentiometer applications requiring something special can mean the difference; cost-savings, improved systems design, and saved space.

Take the rudder control of a commercial aircraft or high-dither element for industrial machinery position-sensing for example, or a long-track hybrid element for scientific recorders; each designed by engineers capable of providing practical answers to complex problems.

Whether the potentiomenter application you have is suited best for a modified standard or a special design from scratch, DUNCAN has led the industry in responsiveness and reliable performance for unusual, cost-conscious requirements.



Solving the housing problem

DUNCAN special potentiometers open new avenues to cost-effective control options. Any of DUNCAN's quality Wirewound, RESOLON® Conductive Plastic or Hybrid elements can be provided in space-saving configurations individually, on customer-supplied or factory substrates, circuit boards, or in linear motion assemblies suited perfectly to the space and functions needed. Wipers and wiper/element assemblies simplify high-performance applications requiring low unit costs. And, connector/cable interfaces can give you a complete module ready for fast, easy installation.

Call or write for applications assistance and information on DUNCAN's standard approach to specials. It can be less than you might have imagined.

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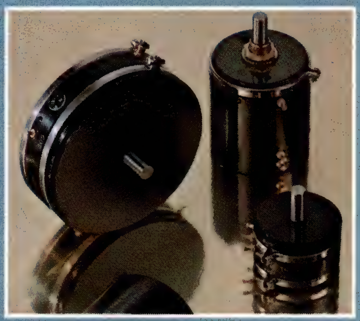

making resistance special

DUNCAN ELECTRONICS
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CIRCLE NO. 45

Tektronix announces the

next generation of scopes.
The 7854.

Now Tektronix offers a new measurement tool for those who depend on oscilloscope measurements — the 7854. It is designed to improve measurement quality yet simplify measurements. Look at these features to see how you can put its measuring power to work for you.

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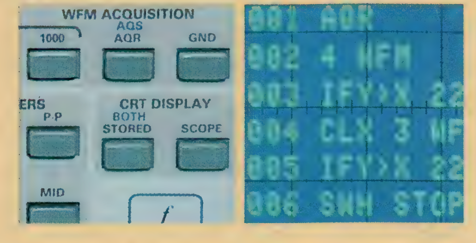
Digital storage lets you view the same node twice or compare waveforms without bothering with waveform photography or having to move probes and repeat control adjustments. Digital storage improves measurement quality, since resolution is increased to .01 division. Averaging improves measurement accuracy on signals buried in noise. With digital storage, you've got an open door to fast waveform processing and more repeatable measurements.

Waveform processing.

At the touch of a button, waveform processing gives you solutions for common waveform measurements like rise time, period, frequency, RMS, energy, mean, max, and mid. Also, cursors aid in delta time and delta voltage measurements.

Within seconds, you can obtain repeatable answers like rise time without having to adjust position controls or determine the number of divisions between points.

Solutions at the touch of a button.



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Like a handheld programmable calculator, the 7854 offers keystroke functions for storing, organizing, and reducing data. You can program the scope to acquire and monitor data without an operator's presence. You can even tailormake special functions to avoid manually repeating a series of keystrokes.

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Part of the Plug-In Family.

The 7854 is the newest member of Tektronix' well-respected 7000-Series family of high performance scopes. Featuring a real time bandwidth of 400 MHz, it's compatible with 7000-Series plug-in units including differential amplifiers, samplers, DVM's, counter/timers, logic and spectrum analyzers, TDR's, and others.

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The 7854 Oscilloscope brochure and accompanying specifications folder provide full details on this new instrument.

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CIRCLE NO. 46

Pots and trimmers are bringing improved resistance, tolerance and tempco values in smaller packages to analog signal processing.

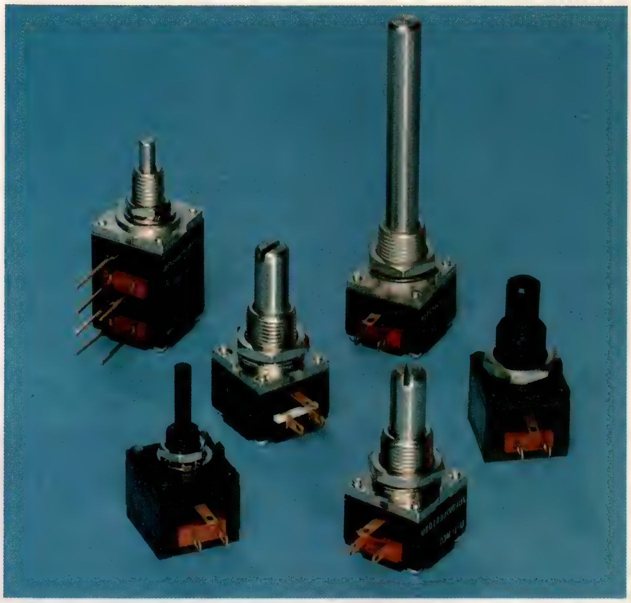
Focus on pots and trimmers: It's survival of the fittest

With their world (analog) shrinking, potentiometers and trimmers are proving eminently adaptable. Offering the best way to put variable-resistance adjustments in the hands of the user is just part of the challenge—they still do that. But with the electronics world increasingly turning to digital processing techniques, and with semiconductor manufacturers depositing precise thin-film resistor networks right on the silicon and relying on lasers for their final trim, pots and trimmers have to prove their mettle at the analog input and output ends of signal-processing circuitry. Survivors of this shift, however, will be the fittest, offering a greater variety of resistance values, tighter tolerances and temperature coefficients, less noise, longer operating life, smaller packages and lower cost.

Potentiometers are going strong in several sectors:

- Precision wirewounds offer the tightest linearities, tolerances and tempcos, while conductive-plastic devices offer long life and infinite resolution. But hybrid potentiometers are emerging as the new contender for both stability and long life.
- Conductive plastics are being widely exploited, not only in highly linear, low-noise, low-cost panel controls, but also where their exceptionally long life and wide choice of substrate materials make unpackaged plastic resistance elements useful—in automotive applications, as position sensors and controls.
- While conductive plastic has the edge in terms of long life, cermet potentiometers provide the greatest power handling and low-cost carbon resistance elements lead the way into higher potentiometer resistance values.
- Among trimmers, Bulk Metal and other thin-film technologies lead the way in terms of stability and repeatability of settings, followed by cermet and carbon. Conductive plastic is used less frequently in

Stephan Ohr, Components Editor



Modular potentiometers, like these Series 70 units from Allen-Bradley, are available with conductive plastic, cermet, or carbon resistance elements, as well as a variety of shaft and bushing styles.

Precision wirewounds, like these Helipot units from Beckman Instruments, still provide the tightest linearities and temperature coefficients.

trimmers, since trimmers don't need particularly long rotational lives.

Doing it with wire

Precision applications such as panel controls for laboratory test instruments and medical instruments have typically relied on precision-wirewound pots for stability, linearity, repeatability of settings, solid mechanical "feel" and long life. The resistance element has typically been a single length of Nichrome (nickel-chromium) wire, wound around a low-permeability doughnut-shaped core. The precious-metal wiper element of the pot adjusts the resistance value by "jumping" from wire-to-wire on the inside diameter of the coil as the shaft is rotated. Nonlinearities for this type of control are frequently on the order of ±0.2%, and tempcos on the order of ±10 ppm/°C.

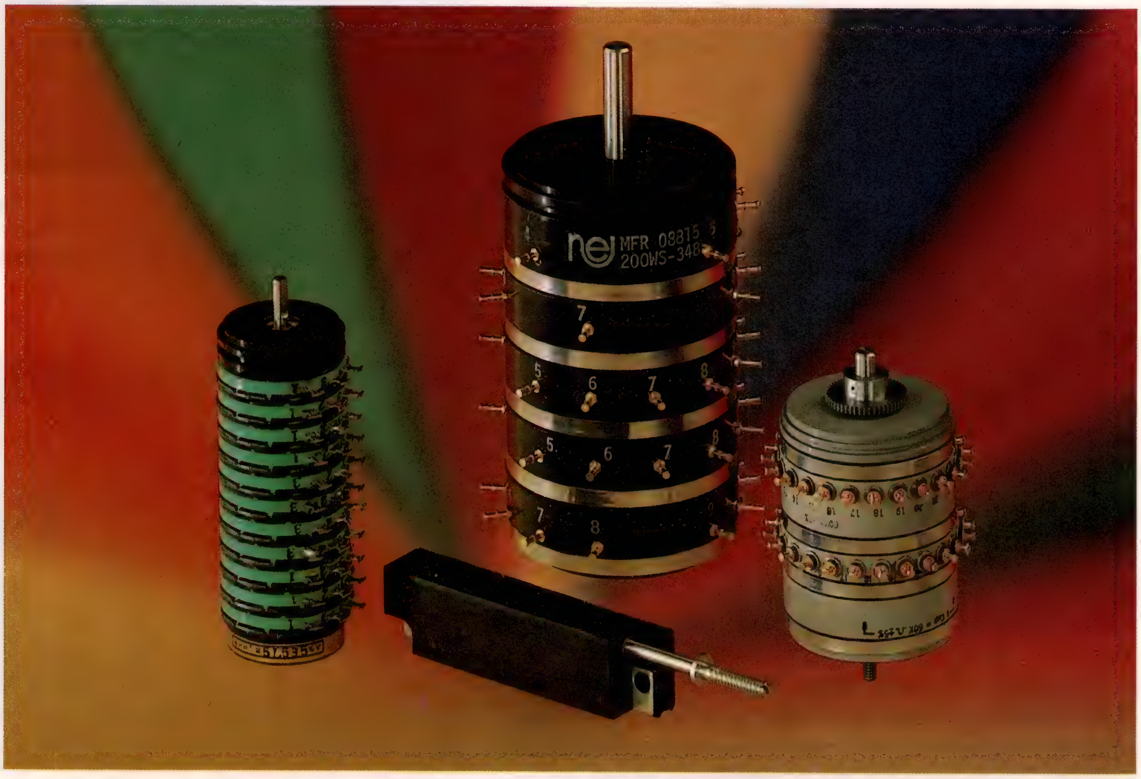
However, resistance values for wirewound pots tend to be limited, since the total resistance value is dictated by the total length of Nichrome wire. Increasing the resistance value requires an increase in the number of core windings. As a result, the precision-wirewound pot increases in size. Compared with cermet or carbon types, wirewounds can be quite large. Diameters of 7/8 in., 1-1/16 in., 1-5/16 in., 1-7/16 in., 2 in. and 3 in. are all standard.

Conductive plastic resistance elements provide low-noise and long-life as in these audio controls from Duncan Electronics.

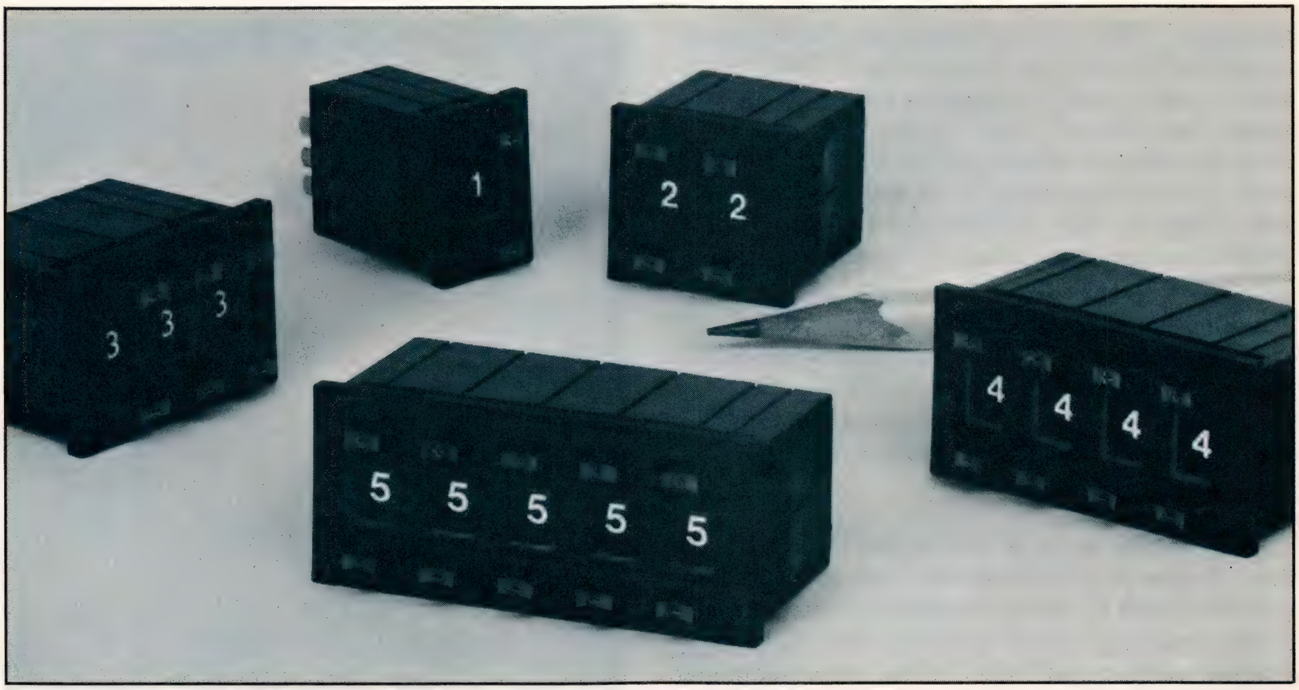
A "miniature" Litton wirewound provides up to 50 kΩ possible (up to 20 kΩ standard), with ±0.2% standard linearity and resolution to within 0.10%—all within a 1/2-in.-diameter frame.

Size has its benefits, though—most precision wirewounds provide several mounting options, including a shaft bushing, or a collar-grip mounting on the outside circular housing, frequently called a "servo" mount. Some manufacturers provide screw-tapped mounting holes on the front of the potentiometer case for panel-mounting.

Largeness aside, precision wirewounds are known for their tight temperature coefficients and their



A large number of potentiometer cups can be stacked on the same shaft with conductive plastic elements. The Waterpot series from New England Instruments can stack up to 12 separate cups with excellent tracking.



Digital potentiometers like these unusual 3680 units from Bourns facilitate repeatable, push-button settings. Laser-trimmed cermet provides a wide range of resistance values, 100 ppm TCRs, and resolution down to 0.001%.

stability under a variety of load and environmental conditions. Beckman Instruments' Helipot Series T, for example, features standard nonlinearity on the order of ±0.5%. Helipot wirewounds provide resolutions to within ±0.09% (for a 15-kΩ unit) and temperature coefficients to within ±20 ppm/°C.

The device is reasonably compact—7/8-in. diameter × 0.770 in. long—and virtually indestructible, with an aluminum housing and shaft bushing, and a stainless-steel shaft. It will handle up to 1.25 W at 70 C, and is qualified according to MIL-R-12934 for shock, vibration, moisture and salt spray from −65 to +125 C, and better than 2-million 354° rotations. Starting torque is 0.5 oz-in.

Don't need the aluminum shell? Beckman's plastic-housed 5100 series 7/8-in.-diameter device will do essentially the same job at lower cost. Nonlinearity is an easy ±0.5%, tempco is ±20 ppm/°C, resolution is within 0.066% for the highest nominal resistance value. But with plastic housing, temperature rating will be −25 to +85 C.

A 7/8-in. version from Litton is housed in an anodized aluminum shell, with stainless-steel shaft and ball bearings for a 0.10 oz-in. running torque over a 340° rotation. Linearity to ±0.15% and resolution down to 0.036% are obtainable. Power-handling ability is better than 2.0 W at 40 C.

A 7/8-in.-diameter pot from New England Instruments offers a wide range of resistance values—100 to 150 kΩ—as well as ±0.2% linearity, a power-handling ability of 1.75 W, and an operating temperature range of −55 to +125 C.

Duncan 7/8-in. wirewounds come in both military (Model 1200) and commercial (Model 1230) versions: The Model 1200 operates over −65 to +125 C in accordance with MIL-R-12934. Commercial versions provide a −55 to +105-C operating range with a tempco specified at ±0.007%/°C. Rotational life is better than 2-million 354° cycles.

Increasing the resolution

While precision-wirewound resolution is good, it is not infinite, because the wiper contact essentially jumps from one strand of wire to another in the coil as the shaft is turned. When this happens, the resistance values sitting between each of the wire turns are lost.

What's more, a great deal of noise is created—which is why precision wirewounds usually carry an ENR rating of 100 Ω. ENR is equivalent noise resistance, expressed as the maximum departure of resistance from a reference line while carrying a specified current between the resistance element and the slider contact.

One way to increase resolution is to make the wiper cover the entire length of the resistance element, rather than "jump" from one spot to the next. Multiturn wirewounds provide higher resolution than single-turn units. Beckman's 7360 series three-turn pots, for example, are 7/8 in. in diameter and about 3/4 in. long, and provide a resolution of 0.037% (for 10-kΩ pots) compared to the 0.092% resolution for equivalent single-turn units. An equivalent five-turn in the 7460 series provides an even tighter resolution, 0.032%, while the ten-turn 7210 pot provides 0.018% resolution. Bourns Model 3500 10-turn wirewounds provide a resistance path which is 20% longer than that of many competitive units for a resolution down to 0.005% (for 500 kΩ pots). The 3500 series units are available in resistance values from 50 Ω to 500 kΩ, with ±3% standard tolerances, and ±0.20% nonlinearities. Noise, however, is still specified as 100 Ω.

A 3-in.-diameter ten-turn pot from Litton, in fact, provides resistance values from 500 Ω to 3 MΩ, linearities to ±0.006% and resolution down to 0.001%, while 3, 5, and 10-turn units are available with good resolution from Spectrol.

Doing it with plastic

Still, the high noise, large size, and limited resolution of precision wirewounds have turned many manufacturers to conductive-plastic resistance elements. Precision plastic pots also have limited resistance ranges and even limited power-handling capabilities. And temperature coefficients are looser —typically ±200 ppm/°C—as are the initial tolerances of ±10%. The resolution, however, is essentially infinite, noise is rated on entirely different scales, and cycle life is anywhere from 5-million to 50-million shaft rotations.

Precision plastic pots from Beckman's 6150 series provide 1 to 10-kΩ, resistance values, ±10% tolerances, approximately ±0.5% standard linearity, 1-W power rating at 70 C and 0.1% output smoothness along with infinite resolution.

Temperature coefficients are −150 to +300 ppm/°C, though the units are qualified for various environments and temperatures from −65 to +125 C by MIL-R-39023. Rotational life is 25-million shaft revolutions. The servo-mounted unit has an aluminum housing and stainless-steel shaft.

A lower-cost version, the Beckman 6180, has a 7/8-in.-diameter plastic housing and a TCR of +200 to −600 ppm/°C over −65 to +125 C. Resistance values as high as 100 kΩ are available, and rotational life is better than 5-million revolutions.

Spectrol Electronics' plastic pots provide resistance values from 1 to 50 kΩ, ±20% standard tolerances (±5% special), standard linearity of ±2.0% (±0.25% special), and ±600-ppm/°C tempcos. And standard operational life extends past 2-million rotations.

A series of single-turn precision pots with conductive plastic from Bourns, the 6500 series provides resistance values of 1 KΩ to 100 KΩ, ±10% standard tolerances, ±0.5% linearity, an easy 25-million shaft rotations, and "essentially infinite" resolution. As if that weren't enough, Bourns has been working on increasing the resolution of conductive plastics with

Unpackaged cermet trimmers like these from Murata still provide good stability over a wide variety of environmental conditions. Plastic wheels permit easy user adjustments anywhere in the pc board.

Environmental packaging is part of the cermet trimmer line from CTS. The 3/8-in. square package protects the device from moisture as well as a majority of board-cleaning fluids.

the development of the Infinitron series. Similar to a 10-turn wirewound, the length Infinitron plastic resistance element is actually stretched by printing it on the surface of an insulated copper wire spun around the circumference of the pot. This unit is not a hybrid, in which the resistance element is essentially the wire coated with plastic. Here, the resistance element is indeed plastic, with insulated wire as the substrate material.

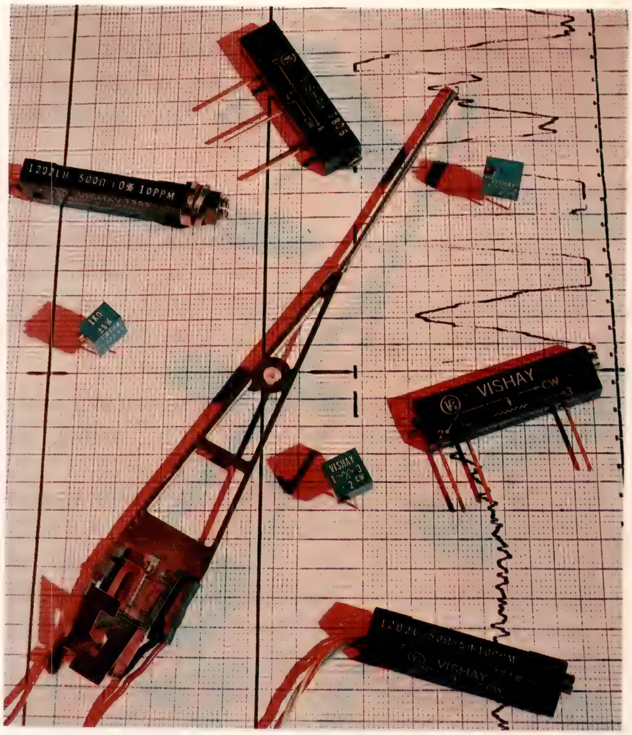
For precision plastic pots, resistance values, stability, noise and rotational life all hinge on the composition of the conductive and resistive particles in a polymer base. To get the best values, then, some companies make their own composition. Resistofilm, for example—a patented composition of fine conductive carbon particles contained in an insulating plastic matrix that is printed on a flexible polymer substrate—is used to give New England Instruments' Econopot line a standard linearity of ±0.25% and output smoothness to within 0.125% per MIL-R-9023.

While spec'd for 10-million cycles, Resistofilm elements are routinely tested up to 25-million cycles and show promise of lifetimes as high as 1-billion cycles.

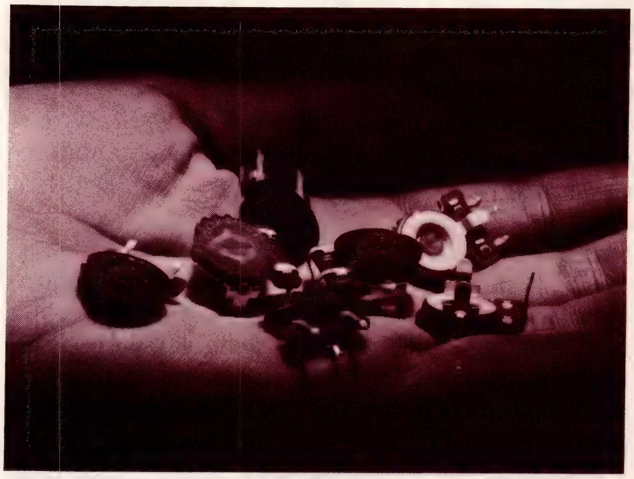
Another resistive plastic composition, Resolon from Duncan Electronics, can even be screen-printed on molded epoxy, epoxy glass, paper, polyimide laminate and phenolic for use in other application areas besides potentiometers. And for good reason: The resistance range for the polymer thick film is 50 Ω per square to 2 kΩ per square. Standard tolerances are ±10%, though ±2% can be specified. Power handling is 3 W/sq in. at 60 C, and the tempco is −400 ppm/°C. The best part, however, is the cycle life: better than 50-million cycles, either in a potentiometer or as an unpackaged part.

The merits of long-life conductive plastic such as New England Instruments' Resistofilm and Duncan's Resolon can be appreciated even more when one realizes that automotive designers are beginning to use conductive plastics and other potentiometric devices as position sensors in automobile engines and controls.

What's more, unlike precision-wirewounds, conductive plastic elements can be laid out linearly, which results in long-life precision linear slide pots—like the ones used in audio mixing and broadcast control consoles. Duncan's 400-series linear slide pots, in fact, provide resistance values from 600 Ω to 250 kΩ, ±20% and ±10% standard tolerances, and ±2% standard linearity (though ±0.01% can be specified). Cycle life is better than 50-million strokes, and the stroke length is either 2-3/4 or 4-1/4 in. Long-life, low-noise linear slide pots are also available from Waters Manufacturing.



Thin-film resistors like these from Vishay lead the way in precision trimming applications. Square and rectilinear units meet MIL-R-39035.



Though carbon is being replaced by cermet, Stackpole's Stabalite resistance elements operate comfortably from −30 to +100 C.

But even as conductive-plastic devices have the edge in terms of life (long) and resolution (infinite), precision wirewounds still lead in terms of tight temperature coefficients. One way to get the best of both technologies is to combine them—to manufacture essentially a precision wirewound with a conductive plastic coating. By using a high-resistivity plastic coating, the manufacturer sees to it that the pot's resistance is determined by the wound wire rather than the plastic. Hybrid pots, such as

Beckman's 7/8-in. 8200 series, provide resistance values of 500 Ω to 10 kΩ, standard linearities of ±0.5%, essentially infinite resolution, tempcos with −150 to +100 ppm/°C, and better than 10-million revolutions of cycle life.

Hybrid precision

Bourns' Hybritron Series, as exemplified by the 10-turn Model 3541, extends the rotational life of precision wirewounds up to 5-million shaft rotations, and provides an output smoothness on the order of 0.015%.

Hybrid single-turn pots from Duncan are available with both the military and commercial ratings as well as in industry-standard diameter sizes of 7/8, 1-1/16, 1-7/16, 1-3/4, 2 and 3 in. Resistance values go to 50 kΩ, standard linearity is ±0.5% (with ±0.075% obtainable), and output smoothness is within 0.075% on the best units. Tempco for all Duncan hybrids is ±0.007%/°C and cycle life is better than 10-million rotations.

However, for highly stable though less-than-precision panel-control applications, conductive plastic is the way to go. Making good use of plastic, Allen-Bradley's, Bourns' and Clarostat's modular potentiometers offer a resistance-value range from 50 Ω to 10 MΩ with ±20% and ±10% standard tolerances. Linearity for these units is within ±5%, and the CRV (contact resistance variation)—a measure of the dynamic noise in ohms or percentage as the wire is moving—is better than 1.0% of the nominal resistance value. These specifications, combined with small size (0.625 in. square × 0.594 in. deep) and available modular packaging options (up to four cups can be ganged, with any number of lug configurations and switch packs) make these modular pots a good choice for high-quality audio equipment and medium-priced analog test instruments. In addition, rotational life is better than 100,000 cycles with less than a 10% total resistance shift (with no load).

Packaging for Allen-Bradley's Series 70, Bourns' Series 8D and Clarostat's 388/389 pots includes a metal shaft and bushing for mounting up to four ganged sections (including switches). Other options include plastic shafts and plastic bushings for low cost, or metal shafts and metal bushings molded into the plastic face plate.

Low TRCs and failure rates, as well as mil-spec qualification are available in these cermet trimmer line from Mepco/Electra.

For very low-power applications (below 0.1 W), Allen-Bradley's miniature, conductive-plastic (0.394 in. cubed) Type M provides 100 Ω to 1 MΩ with ±20% standard tolerances and a CRV of 2% or 3 Ω, whichever comes out higher. The device has a plastic bushing, shaft and case, but is useful from −25 to +100.

Conductive plastic is the resistance element behind Bourns' low-cost 9100-series pots. The resistive ink is printed on a Ryton substrate, and inserted in a diallyl-phthalate plastic shell. Shafts are plastic with aluminum bushings. As with Bourns' low-noise pots, the wiper element consists of 28 nickel-silver leaf springs that produce a CRV of ±1% or 3 Ω over a 240° ±5° electrical travel. Starting torque is less than 2.0 oz-in. The cycle life is rated at 100,000 rotations, though the devices have been tested successfully up to 1-million cycles. Resistance values are 250 Ω to 5 MΩ with ±20% and ±10% standard tolerances. Tempcos are well within ±1000 ppm/°C.

Enter cermet

Somewhere between the high resolution of plastic and the high tempcos of precision wirewounds lies cermet (bismuth-ruthenium oxide with glass binders), which offers the same resistance values as plastic but with tighter temperature coefficients. Allen-Bradley's, Bourns' and Clarostat's pots offer a choice of resistance elements. The cermet element offers the same resistance values, 100 Ω to 1 MΩ, with ±100% and ±20% tolerances and the same rotational life (100,000 cycles) as the conductive-plastic elements but a much higher power rating of 2 W, compared to 0.5 W for conductive plastic, a slightly higher CRV (±1.5%) and tighter temperature coefficient of ±50 to ±100 ppm/°C, compared to ±400 to ±1000 ppm/°C for conductive plastic. The Allen-Bradley SP cermet pots work from −55 to +150 C, are 0.375 in. in diameter and 0.438 in. long and are immersion-sealed. CRV is less than 3% of nominal resistance value.

Trimming-in

Other manufacturers of cermet panel controls include CTS, whose instrument-grade 5/8-in.-diameter series 205 can take up to 2 W of power at 70 C. Standard resistance values are 100 Ω to 2.5 MΩ with ±20% tolerances (though 50 Ω and up to 5 MΩ can be specified, as well as ±10% tolerances). Standard linearity is ±5%. Tempcos are well within ±250 ppm/°C and rotational life is 25,000 cycles.

While potentiometers and panel controls are intended for frequent or continuous user adjustment, trimmers are adjusted infrequently in the life cycle of a product. For this reason, their rotational life is not as important as the resistance values, resolution, freedom from drift and a number of packaging considerations including size and resistance to environmental elements.

As expected, long-life conductive plastics are not widely used in trimming applications. Cermet and metal thin-film cermets and carbon-comps are typically found in industrial and consumer electronics, while the thin-film devices such as Vishay's Bulk Metal trimmers or Litton's micropot wirewounds can be used in laboratory instruments and avionics equipment.

Cermet, however, is the resistance element used in a majority of trimming applications as well as in Bourns' Multi Function Trimmers (MFTs). The MFTs are combinations of resistance networks and trimmers housed in environmentally-sealed mini-DIP packages. Not only are the MFT DIPs compatible with rapid automatic insertion equipment, resistance and trimmer values can be selected and configured for a large number of trimming applications. A single MFT, for example, can be combined with one capacitor and an op amp to form the essentials of an adjustable high-Q notch filter which takes up practically no pc board space.

With a choice of resistance values from 500 Ω to 500 kΩ and a wide variety of standard configurations available, the application possibilities are almost limitless. Like all cermet resistance elements, the TCR is on the order of 50 ppm/°C over the temperature range from −55 to +125 C. Rotational life is 200 cycles.

Cermet trimmers from Bourns, Beckman and other manufacturers are available with environmentally-protected square or rectilinear packing. Rectilinear packages are typically 0.75-in. long, 0.19-in. wide and 0.350-in. high. Square packaged units are typically 3/8-in. square and 1/4-in. wide. Resistance values from 10 Ω to several megohms are available, with TCRs on the order of ±100 ppm/°C. In addition to Bourns and Beckman, suppliers of high-grade, environmentally-sealed cermet trimmers include CTS, Dale, and Weston Components.

For low-cost applications such as consumer electronics, cermet trimmers with no environmental protection are available. These cermet devices are less affected by temperature changes (TCR is frequently within ±200 ppm/°C) than by humidity, although products like Centralab's Cerbon (ceramic and carbon) element trimmers will typically drift less than ±5% after 96 hours of 95% relative humidity at 40 C. Centralabs' Cermet trimmers will stay within 1% under the same conditions. Other suppliers of Cermet include Spectrol, Murata, Panasonic, and others.□

Need more information?

For more information on panel and trimmer potentiometers, readers may consult manufacturers listed here by circling the appropriate numbers on the reader service card. Space limitations prevent listing more vendors, but ELECTRONIC DESIGN'S GOLD BOOK provides a comprehensive breakdown by type for both domestic and foreign manufacturers.

Allen-Bradley Co., 1201 S. 2nd St., Milwaukee, WI 53204. (414) 671-2000. **CIRCLE NO. 451**

Angstrohm Precision Inc., 1 Precision Pl., Hagerstown, MD 21740. (301) 739-8722. **CIRCLE NO. 452**

Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, CA 92634. (714) 871-4848. **CIRCLE NO. 453**

Betatronix Inc., Nicon Court, Hauppauge, NY 11787. (516) 543-8780. **CIRCLE NO. 454**

Bourns Inc., Trimpot Products Div., 1200 Columbia Ave., Riverside, CA 92507. (714) 781-5122. **CIRCLE NO. 455**

Centralab Electronics, Div. of Globe-Union Inc., 5757 N. Green Bay Ave., Milwaukee, WI 53201. (414) 228-1200. **CIRCLE NO. 456**

Clarostat Manufacturing Co., Washington St., Dover, NH 03820. (603) 742-1120. **CIRCLE NO. 457**

CTS Corp., 905 N. West Blvd., Elkhart, IN 46514. (219) 293-7511. **CIRCLE NO. 458**

Dale Electronics, 1376 28th Ave., Columbus, NE 68601. (402) 564-3131. **CIRCLE NO. 459**

Duncan Electronics Inc., Subsidiary of Systron Donner, 2865 Fairview Rd., Costa Mesa, CA 92626. (714) 545-8261. **CIRCLE NO. 460**

Litton Systems Inc., Potentiometer Div., 750 S. Fulton Ave., Mount Vernon, NY 10550. (914) 664-7733. **CIRCLE NO. 461**

Mallory Distributor Products Co., Box 1284, Indianapolis, IN 46206. (317) 856-3731. **CIRCLE NO. 462**

Mepco/Electra Inc., Columbia Rd., Morristown, NJ 07960. (201) 539-2000. **CIRCLE NO. 463**

Murata Corp. of America, 1148 Franklin Rd. S.E., Marietta, GA 30067. (404) 442-9777. **CIRCLE NO. 464**

New England Instrument Co., Potentiometer Div., 52 Kendall Lane, Natick, MA 01760. (617) 875-9711. **CIRCLE NO. 465**

Ohmite Manufacturing Co., 3601 Howard St., Skokie, IL 60076. (312) 675-2600. **CIRCLE NO. 466**

Panasonic Co., Div. of Matsushita Electric, 1 Panasonic Way, Secaucus, NJ 07094. (201) 348-7000. **CIRCLE NO. 467**

Piher International Corp., 505 West Golf Rd., Arlington Heights, IL 60005. (312) 640-8300. **CIRCLE NO. 468**

Spectrol Electronics Corp., 17070 E. Gale Ave., City of Industry, CA 91745. (213) 964-6565. **CIRCLE NO. 469**

Stackpole Components Co., P.O. Box M, Farmville, VA 23901. (804) 392-4111. **CIRCLE NO. 470**

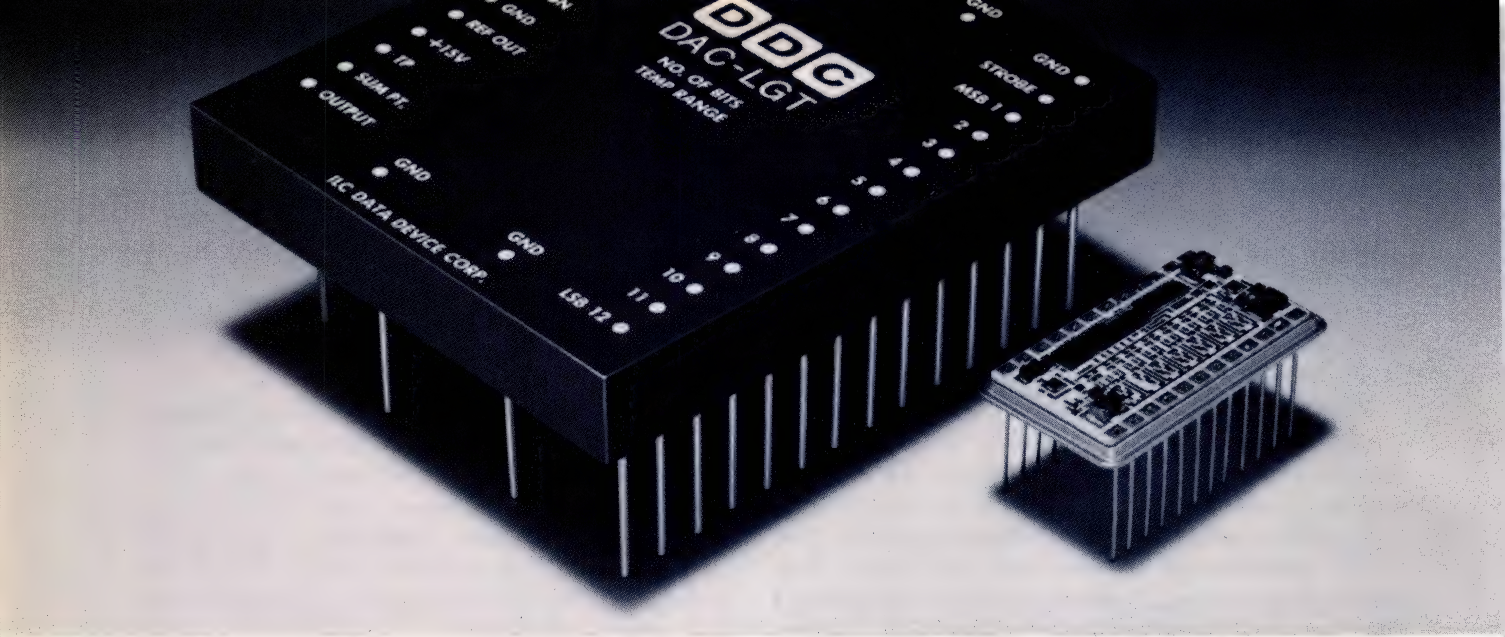
Vernitron Corp., Vernitech Div., 300 Marcus Blvd., Deer Park, NY 11729. (516) 586-5100. **CIRCLE NO. 471**

Vishay Resistive Systems Group, 63 Lincoln Hwy., Malvern, PA 19355. (215) 644-1300. **CIRCLE NO. 472**

VRN, Div. of Vernitron, 2801 72 St. North, St. Petersburg, FL 33710. (813) 347-2181. **CIRCLE NO. 475**

Waters Manufacturing Inc., 1 Longfellow Center, Wayland, MA 01778. (617) 358-2777. **CIRCLE NO. 473**

Weston Components and Controls, Div. of Sangamo Weston, Inc., Archbald, PA 18403. (717) 876-1500. **CIRCLE NO. 474**



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DDC

ILC DATA DEVICE CORPORATION

EXECUTIVE OFFICES: ILC Data Device Corporation, Dept. **F-3**, 105 Wilbur Place, Bohemia, N.Y. 11716, (516) 567-5600, TWX: 510-228-7324.
LOS ANGELES: ILC Data Device Corporation, Dept. **F-3**, 7337 Greenbush Avenue, No. Hollywood, CA 91605, (213) 982-6454, TWX: 910-499-2674.
LONDON: DDC United Kingdom Ltd., Dept. **F-3**, 128 High Street, Hungerford, Berkshire, RG17 ODL, England (44) 4886-2141/2142, TLX: 851-848826.
PARIS: DDC Electronique, Dept. **F-3**, 4 Rue De Abreuvior, 92400 Courbevoie, France, TLX: 842-630609.

CIRCLE NO. 55

CMOS memory system for 8 and 16-bit Multibus systems includes on-board battery to provide power in case of line failure.

16-kbyte RAM board retains data for 7 days

The BP-0200 RAM board provides 16 kbytes of nonvolatile read/write memory to 8 and 16-bit Multibus systems. The nonvolatility comes from three AAA-sized Ni-Cd cells that can power the memory in its standby mode for up to seven days. When fully charged, the battery can delivery 180 mA-h at 3.6 V.

Jumpers on the board let users locate the memory anywhere within a 1-Mbyte field, along any 16-k boundary. The 16-k boundary starts at 0X000H—that is 04000H, 08000H, 0C000H, etc. Because of their memory-inhibit functions, two or more BP-0200 boards can be used in a paging mode. For even more flexibility, memory may be deselected by the jumpers in 2-kbyte blocks.

Populated with NEC's μPD444/6514 CMOS RAMs, the board responds in 450 ns (max) for read access and 600 ns (max) for read cycle. To ensure smooth operation with a Multibus, the TTL-compatible interface is offered with two connectors. One is an 86-pin double-sided connector. Its pins are on 0.156-in. centers. The other is a 60-pin double-sided connector, with 0.100-in. spacing.

The BP-0200 has input and output control ports for testing the on-board battery, checking the status of the memory-inhibit function and checking (and resetting, if necessary) the power-fail sensing circuitry.

When the ac power fails or drops below 103/203 V ac, the power-fail sensing circuit is activated. Then the board's ac power-low (ACLO) pin goes high, initiating an orderly power-down sequence. The processor is immediately interrupted so that it may store machine status. Approximately 3.8 ms after the power-fail interrupt, all further access to the BP-0200 is denied until system power is restored. The power-fail sensing circuit may be disabled for battery changing or for storing the memory board.

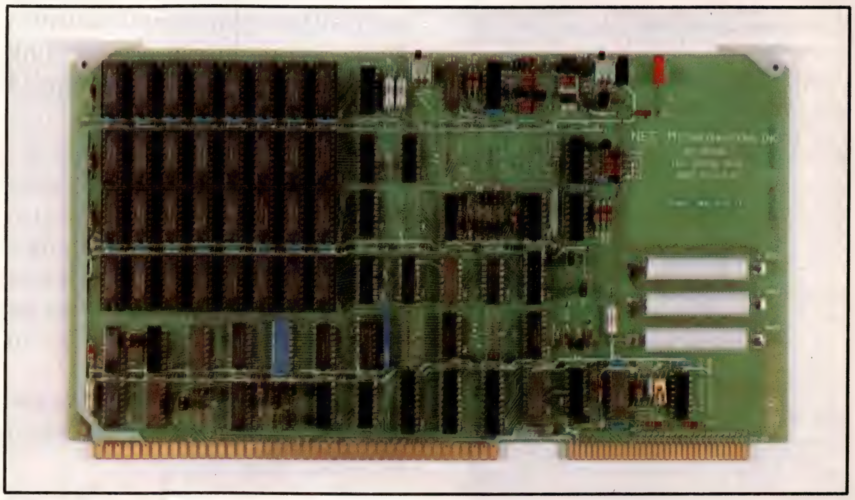
The board measures 12 × 6.75 × 0.5 in. (30.48 × 17.15 × 1.27 cm) and weighs 376 grams. It operates between 0 and 55 C, at a noncondensing relative humidity of 90% or less.

The power requirements are modest. The BP0200 draws a maximum of 1.2 A from a 5-V dc supply; typically it needs no more than 0.9 A. Battery charging takes 14 hrs for a full charge of 180 mA-hrs. The on-board charging circuitry provides protection against overcharging and short circuits.

The BP-0200 sells for $1775. It has a delivery time of 45 days ARO.

NEC Microcomputers, Inc., 173 Worcester St., Wellesley, MA 02181. Brian Doherty (617) 237-1910.

CIRCLE NO. 304



The BP-0200 CMOS RAM board operates as a slave to the system processor, but contains its own power source for use during a power failure.

Len Yencharis, Computer Editor

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VACTEC LDR'S are photoconductive cells responding to visible light by proportional resistance change. A typical cell such as the VT833 will be >10MΩ under moonlight illumination and <1.0KΩ in room light. Their small size, low cost, and spectral range of 400-700nm makes LDR's an excellent ambient light sensor for day/night threshold controls, automatic brightness controls for CRT terminals, TV sets, digital clocks, automotive, and aircraft instrument displays. Apply them as any variable resistance.

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VACTEC LDR's are rated at 500 peak V for use in 115 and 230 VAC direct relay controllers, SCR and triac gating.

VACTEC LDR's come in five ceramic and three hermetic cases; 6 materials; wide range of resistance levels to match discrete, TTL and CMOS circuits. For additional information on these versatile and low cost devices, request Bulletin PCD-6.

VACTEC,
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St. Louis, MO 63132
(314) 423-4900
TWX 910-764-0811

CIRCLE NO. 56

Interface supports high-speed VAX-11/780

A hardware interface, DR780, supports high data-rate applications for VAX-11/780 computer systems. A microprocessor-controlled, 32-bit parallel interface, DR780 transfers data between external devices and the 11/780 memory at rates up to 6.67 Mbytes/s. The unit is designed for very high data throughput from such devices as array processors, sensor-based I/O and other data acquisition equipment. It will also serve as an interprocessor link between two DR780-equipped VAX-11/780 systems. A synchronous 32-bit parallel data interconnect and an asynchronous 8-bit control interconnect are provided. Data and control signals can be transmitted simultaneously. Up to 80 ft of cable can be used to connect the DR780 to external devices.

Digital Equipment, 129 Parker St., Maynard, MA 01754. (617) 897-5111. $18,700.

CIRCLE NO. 320

I/O modules interface with Naked Mini μCs

A pair of 64-bit TTL input/output modules interfaces Naked Mini 4 computers to industrial control jobs. The interfaces allow a variety of I/O data formats to be monitored by the computer, including four 16-bit words or up to 64 discrete stimuli, such as switch closures. Byte or word data formats are supported with each module. The half-card modules handle positive and negative true input or output. Latched or transparent inputs can be interfaced to a processor.

Computer Automation, 2181 Dupont Dr., Irvine, CA 92713. (714) 833-8830. $400.

CIRCLE NO. 321

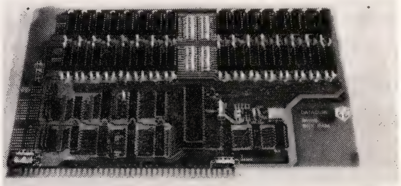
Disk controllers emulate DEC/DG systems

A line of single-board disk controllers emulate similar DEC Data General types. EDC24 interfaces to any DEC LSI-11 computer and emulates several subsystems, including the RK06/07 and RM02/03. EDC22 works in Data General's Nova and Eclipse computer, emulating the Zebra controller. EDC21 is for users of DEC's PDP-11 mainframe. EDC24 and 21 include 32-bit ECC, correcting bursts of up to 11 bits. Single-command, multiple-sector transfers of up to 64 kwords are possible. EDC22 is capable of 32-bit ECC and offers a selectable DMA throttle rate and three-sector buffering.

MiniComputer Technology, 2470 Emcarcadero Way, Palo Alto, CA 94303. (415) 856-7400. $4500 (EDC24, 21); $4400 (EDC22); 13 to 26 wks.

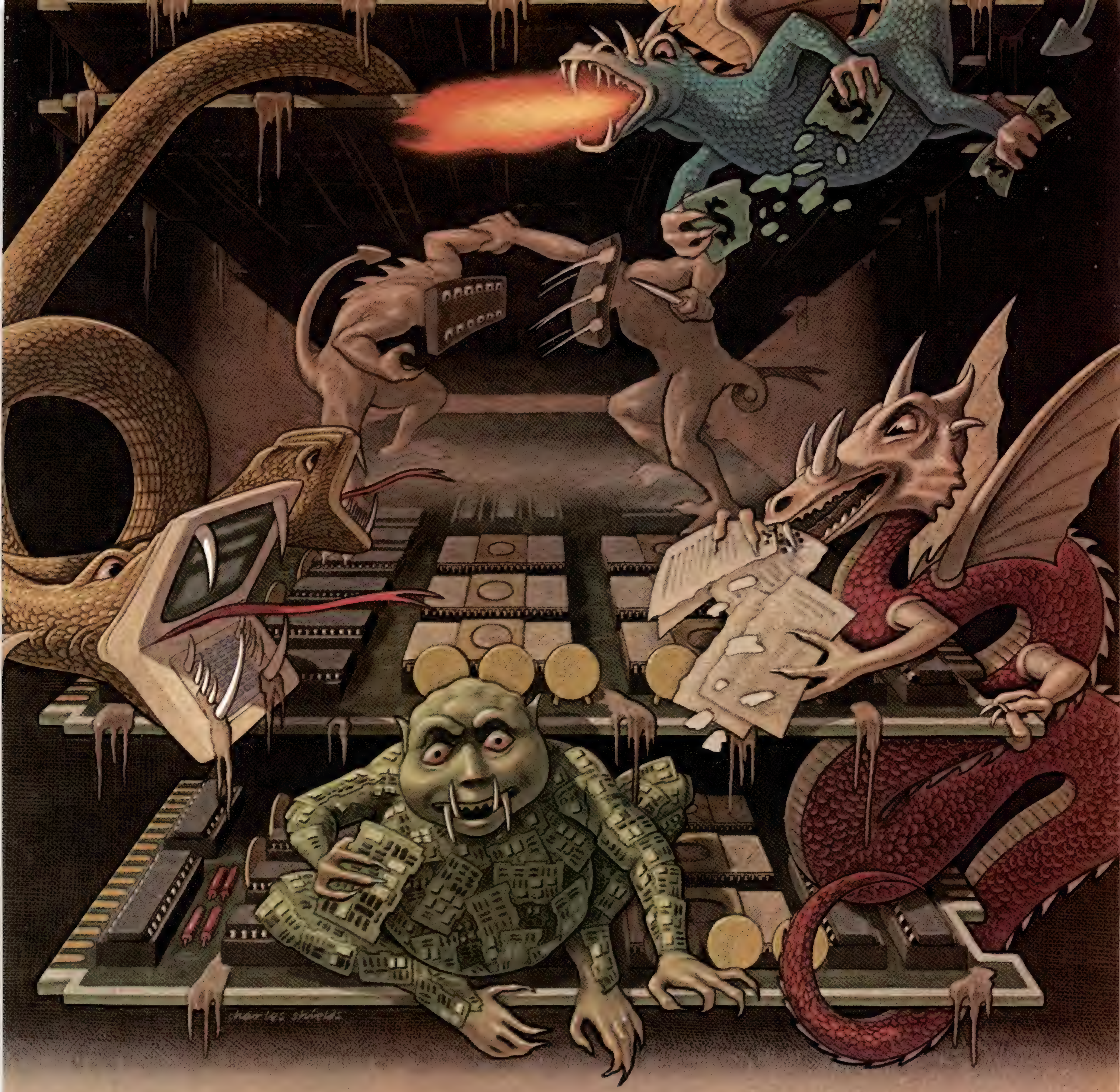
CIRCLE NO. 322

Read/write board expands Multibus



A read/write memory board, RM-119, incrementally expands a Multibus systems by up to 64 kbytes. The high-density board boosts the storage capacity of Intel's SBC/NSC BLC single-board computer in 16-k increments. On-board refresh is provided. The board can be used with 16 or 20-bit address buses and can be selectively disabled in sixteen 4-k blocks. Sockets are provided for 4116 memory ICs.

Datacube, 670 Main St., Reading, MA 01867. (617) 944-4600. $495 to $1650. **CIRCLE NO. 323**



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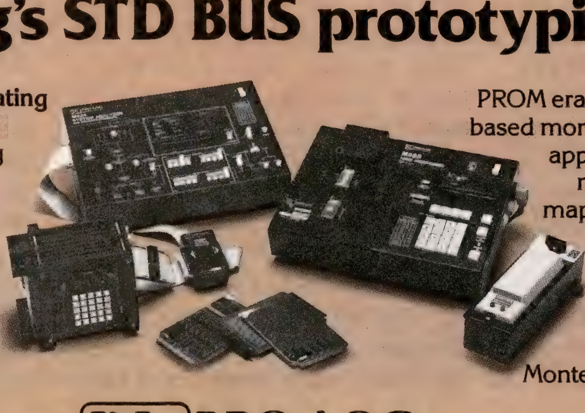

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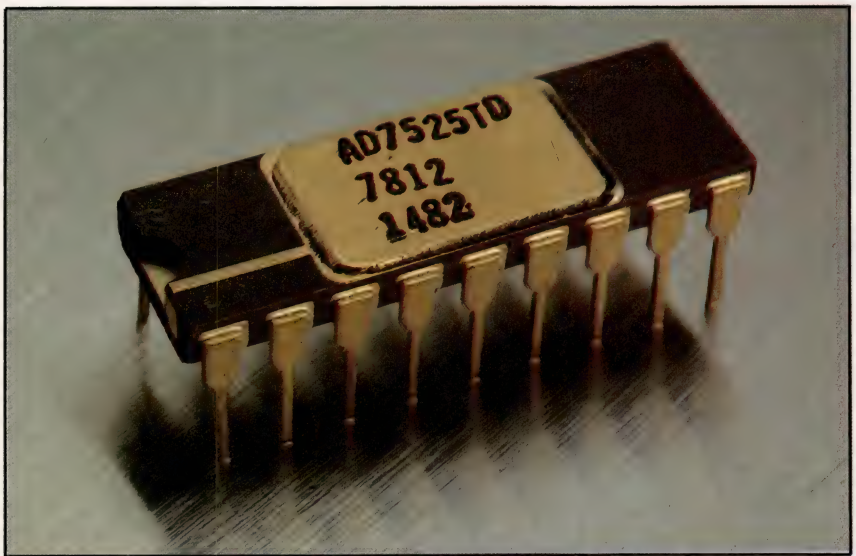
With Pro-Log's STD BUS prototyping system you avoid incompatible parts, overdesigned products, complex instrumentation, software and documentation horrors and highflying costs. The system contains a Z80 or 8085A STD BUS processor card, card rack, power supply, keyboard display card, utility cards, PROM programmer, PROM erase light, system analyzer, PROM-based monitor program with operating and applications software, 2716 PROMs, manuals, program coding forms, maps, instruction books, application notes, and detailed monitor program documentation. **Only $5,800 complete.** From Pro-Log Corporation, 2411 Garden Road, Monterey, CA 93940, (408) 372-4593.

PRO-LOG
CORPORATION

CIRCLE NO. 57

This multiplying CMOS d/a converter competes with precision wirewound potentiometers—and wins.

DAC with BCD inputs works like digital attenuator



Unlike conventional potentiometers, the AD7525 presents a high input impedance regardless of its load or setting.

Take a CMOS multiplying DAC that accepts BCD inputs, add a set of thumbwheel switches and an op amp, and the result is of one of the most accurate potentiometers that is commercially available. Especially suited for applications in test equipment, industrial process controls, and large equipment in which the pot must be located far from its front-panel control, Analog Devices' AD7525 provides a resolution of better than 0.05%, nonlinearity of less than ±½ LSB over its BCD range of 0.000 to 1.999, a maximum gain error of 0.05% of full scale, and a temperature coefficient of less than 25 ppm/°C.

The best ten-turn wirewound pots may provide similar resolutions and tempcos, but they can neither guarantee repeatability nor present constant impedances to the circuitry with which they interface. The AD7525 is repeatable to within 0.2% of the input voltage, and accurate to within 0.3% of the V_{IN} for its entire temperature range.

Though designed to handle analog inputs in the range of ±10 V, the AD7525 will handle a maximum input voltage swing of ±25 V. Another advantage of using a CMOS device as a potentiometer is that the input of the AD7525 always presents a high impedance, which ranges from 2 to 10 kΩ. Output impedances, in addition, are always in the range from 8 to 40 kΩ with capacitance less than 200 pF.

The CMOS device functions from a single supply voltage in the range of +5 to +17 V, with a recommended value of +15 V. Current draw is typically 500 μA at 25 C and 1 mA maximum over the entire operating temperature range.

The CMOS device will compete with ten-turn pots and digital switching assemblies not only in terms of performance but also in terms of cost. In quantities of 100, the AD7525 KN, a plastic commercial version with ±1-LSB nonlinearity intended for 0 to 70 C, costs $12.00, which approaches the cost of some of the best precision wirewounds. The AD7525LN, also packaged in plastic for use between 0 and 70 C but with a nonlinearity better than ±½ LSB, costs $14.00 in 100s. Other versions of the AD7525 are packaged in ceramic for industrial (−25 to +85 C) and military (−55 to +125 C) uses. All versions are available from stock to eight weeks after receipt of order.

Analog Devices, Route 1 Industrial Park, P.O. Box 280, Norwood, MA 02062. Jerry Whitmore. (617) 329-4700.

CIRCLE NO. 307

Stephan Ohr, Components Editor

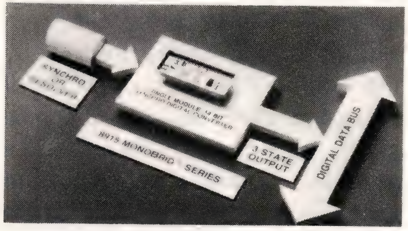
200-ns s/h amp stays linear within ±0.002%

Model 1410, a high-speed sample and hold amplifier, features a maximum acquisition time of 200 ns to 0.1% accuracy and 350 ns to 0.01% accuracy. Total nonlinearity from all error sources, including pedestal variation, is ±0.002% maximum. Transient settling time is 100 ns maximum to ±0.01%. The unit is available with a fully-buffered input, as the Model 1411. The high-impedance input eases drive requirements. Power requirement is ±15 V, ±3% at 25 mA maximum. The module measures 2 × 2 × 0.4 in.

Dynamic Measurements, 6 Lowell Ave., Winchester, MA 01890. (800) 225-1151. $175 (small qty); 4 wks.

CIRCLE NO. 324

Hybrid packs 14-bit s/d conversion in 36-pin DIP



Using two custom, monolithic chips and four ICs, 14-bit s/d and r/d converters are packed into a standard 36-pin, double-width hybrid package. HSDC-8915 Monobrid Series devices allow a maximum error of only ±4 minutes, ±0.9 LSB or ±2.6 minutes. This accuracy, which includes quantizing error, is maintained under all static and dynamic conditions at speeds up to 2 revolutions/s. Accuracy is unaffected by carrier amplitude variation. The converters accept broadband inputs of either 360 to 1000 Hz or 47 to 1000 Hz. The output angle is in natural binary code with parallel positive logic. Features include a ±2.6 minute high-accuracy option, a transparent latch to keep the converter tracking while an inhibit command is applied and error-voltage outputs. All logic I/O is buffered to accommodate any external TTL or CMOS level between ±4.5 V and the 15-V supply level. Units are processed to MIL-STD-883.

ILC Data Device, 105 Wilbur Pl., Bohemia, NY 11716. (516) 567-5600. $375; stock to 6 wks.

CIRCLE NO. 325

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When a lighted push-button switch display requires something special, knowing all the options will mean the difference in being able to use a slightly modified standard that costs less and product availability you're able to live with.

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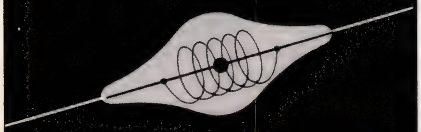
CIRCLE NO. 58



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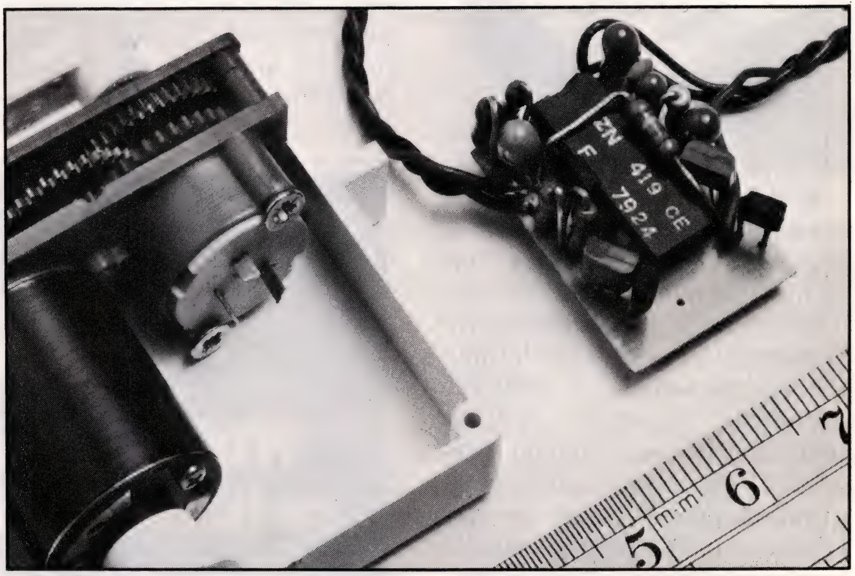
Servo IC for radio control helps conserve power



The ZN419CE monolithic servo controller has many power saving features, making it well suited for battery-powered applications.

Specifically designed for radio control applications, Ferranti Electric's ZN419CE precision servo IC contains the major components of a feedback control system. Housed in a 14-pin molded DIP, the time-division-multiplexed circuit controls pulse-width position servos in small mechanisms.

The monolithic controller can operate from a single 5-V supply and draws just 6.7 mA in the quiescent state, making it suitable for battery-operated equipment. A balanced deadband control circuit prevents the control system motor from hunting around its quiescent point, thus increasing battery life.

Drive capability of the on-chip pnp output transistors is 40 mA min and 70 mA max at 25 C. At −10 C, the values are 35 mA min and 65 mA max. Saturation voltage of the output transistors is at most 0.4 V, at a load current of 400 mA.

The chip contains a voltage regulator that has a nominal output of 2.2 V. This output supplies 1.3 mA from −10 to 65 C.

Total dissipation from the DIP package may not exceed 300 mW, and the operating temperature range is −20 to +65 C.

A nonlinear pulse-expansion circuit with a Schmitt-trigger output prevents the motor from remaining stationary and drawing full stall currents for small drive periods. Stall current can be many times greater than the IC's quiescent current, a condition that severely restricts battery life in remote-controlled equipment.

In 1000 piece quantities, the devices cost $2.20 each. The price is $3.25 in lots of 100 pieces. Delivery time is from four to eight weeks.

Ferranti Electric Inc., Semiconductor Products, 87 Modular Ave., Commack, NY 11725. Ken Kushman (516) 543-0200.

CIRCLE NO. 303

Analog input module connects to μPs

A hybrid analog input system, MP32, connects to popular microprocessors with little additional logic. The ±10 V system reduces costs by providing internal interface logic for direct application with 8080A, 8048, Z80 and SC/MP microprocessors. The memory-mapped module needs only simple programming instructions to acquire data, thus simplifying software development. Nonlinearity is ±0.125%. The compact, 80-pin ceramic quad package occupies only 3.75 in.^{2} of board space. MP32's a/d converter is a 12-bit successive approximation device offering 35 μs conversion time and three-state outputs.

Burr-Brown, P.O. Box 11400, Tucson, AZ 85734. (602) 746-1111. $267 (100 qty); stock.

CIRCLE NO. 326

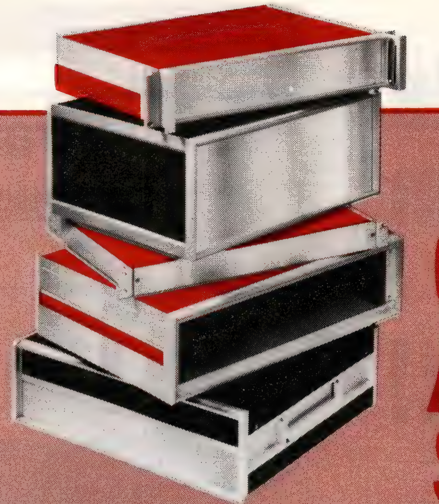
Multipliers give product of two variables

Hybrid four-quadrant multipliers, Models 403 through 406, give the instantaneous product of two variables. The miniature devices include a transconductance multiplying element, a stable reference and an output amplifier, internally trimmed for feedthrough output zero and gain trim. Transfer function is XY/10; multiplying errors (at 25 C) range from 1 to 0.1%. The 0.1% accuracy specification includes the effects of offset voltage, feedthrough, scale factors and nonlinearity.

Family features include 0 to 70-C operation, ±10 V at 5-mA output, a 1-MHz small-signal bandwidth, a 750-kHz full-power bandwidth and a slew rate of 45 V/μs.

SGR, Neponset Valley Industrial Park, Canton, MA 02021, (617) 828-7773. $55 to $150; stock to 4 wks.

CIRCLE NO. 327



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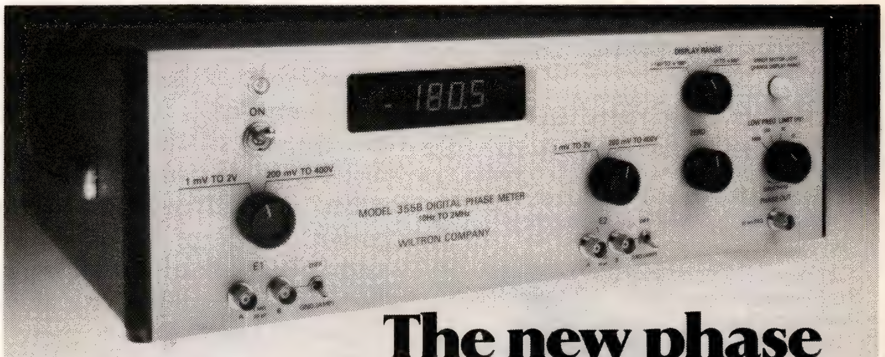
CIRCLE NUMBER 59 FOR CASES
CIRCLE NUMBER 60 FOR KNOBS



The new phase meter to take the fourth dimension digitally.
It's a Wiltron.

Wiltron's Model 355B Digital Phase Meter accurately measures the phase difference between two signals. Signal frequencies can fall anywhere between 10 Hz to about 5 MHz with performance specified to 2 MHz. Measurement accuracy is typically within 0.1°

Two signals of greatly varying amplitudes can be measured over a combined dynamic range of 112 dB, 66 dB (1mV to 2V or 0.2V to 400V) per channel.

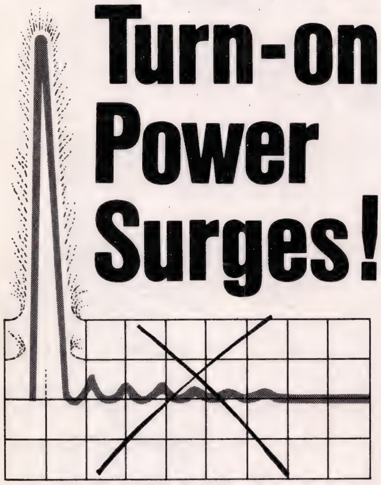
For maximum accuracy, an error sector indicator guides the user to select the appropriate display range. Measurements are always made at optimum test settings. Display is 4-digit LED. A voltage proportional to phase output is provided for remote displays.

Price of the Model 355B is $2150. For complete information, address Wiltron, 825 E. Middlefield Road, Mountain View, CA 94043.
Phone (415) 969-6500. TWX 910-379-6578.

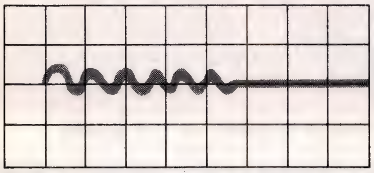
WILTRON

CIRCLE NO. 61

Eliminate Turn-on Power Surges!



NEW SURGELESS SOLID STATE RELAY™ SOLVES THE PROBLEM.



Now you can reduce or eliminate damaging inrush surge currents when switching highly inductive iron core loads. All you need is our new SURGELESS SOLID STATE RELAY.

This new switching technique extends the life of the SSR, eliminates the need to protect for EMI, and is the most definitive solution to power surges on the market!

Our new SSR does so much we don't have enough room here to tell you about it. Call or write, and get the full story. TODAY!

FEATURES:

- Unique phase sensing circuitry allows load turn-on to occur in such a way that surge currents are eliminated
- Elimination of surges substantially increases relay life
- Simple four-terminal device in standard AC Solid State Relay packaging
- Switching capabilities up to 25 AMPS at 240V RMS
- Protection from transient noise which causes false firing is 400 V/μ sec @ 25°C; 200 V/μ sec @ 85°C

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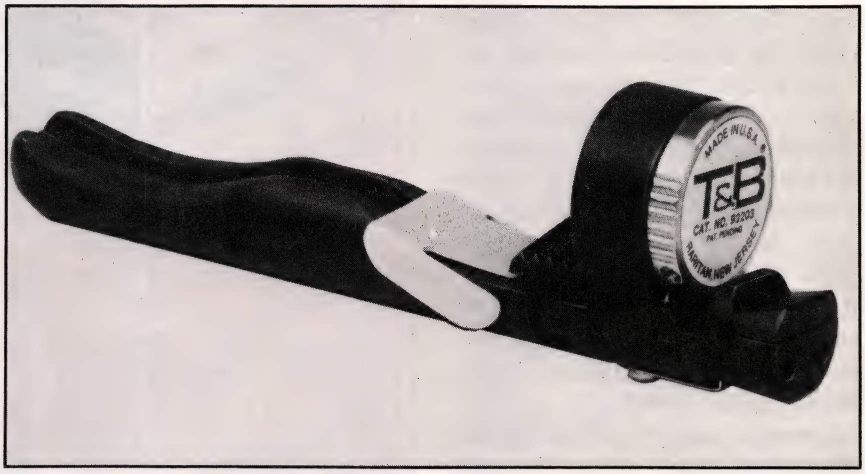
CIRCLE NO. 62

Straight-pull tool breaks fibers better



A silica fiber is held in place in the slotted handle of the tool, while it is scored by a diamond blade and then cleaved by a longitudinal pull.

An easy-to-use scribe-and-break tool gives practical proof to research that shows a straight-pull technique is the best means for severing glass optical fibers. The research, conducted by the Optoelectronics Group of Thomas and Betts Corp., is embodied in the company's hand-held cleaving tool, No. 92203. The portable tool, which is easily carried in the pocket, is part of a line of tools and other equipment from T&B/Optoelectronics for making splices in the field.

Silica fibers are stripped and inserted into the tool along a slot in the handle. The fiber is held in place by the pressure of the user's thumb on a leather clamp. With a single turn of the knurled knob at the head of the tool, a long-wearing natural diamond blade scores the fiber. A tug on the top clamp of the device pulls the fiber ends apart.

The resulting break is not only clean and smooth, but also within 1° (typically) of the perpendicular. More than 90% of all breaks are within 3°.

Interferometry research at T&B/Optoelectronics has revealed that low-loss fiber-optic splicing is contingent on smooth and clean fiber ends and perpendicular fiber faces. As the face of the fiber deviates from the perpendicular, coupling losses increase, sometimes dramatically. A deviation of more than 3° produces coupling losses in excess of 0.5 dB. Larger deviations produce much larger losses.

Although many scribe-and-break tools for silica fibers will produce smooth breaks, most do not leave perpendicular faces on the fiber ends, because their cleaving action involves bending the fiber around the circumference of an imaginary circle. The straight-pull after scoring technique, on the other hand, produces fiber faces which are equally smooth and consistently closer to perpendicular.

The price for each No. 92203 cleaving tool is under $1,000. Delivery takes eight to ten weeks.

Thomas and Betts Corp., 920 Rt. 202, Raritan, NJ 08869. John Kaufmann (201) 685-6100.

CIRCLE NO. 309

DVM Downtime

How often do you send your DVMs to the cal lab? Every three months? Every month? Or are you making ultra-precision measurements that require weekly or daily calibration? Now, how long do you have to wait to get them back? A few hours? A few days? A few weeks? How much time and money could you save if it took fifteen minutes or less to calibrate a DVM. Not a zeroing out, but a complete calibration of every range and every function including AC high frequency and input bias current.

Well, that's what you can do with Datron's AUTOCAL.

The Datron Autocal covers every range and every function without plug-in boards or separate modules. Complete calibration of AC, DC, ohms and current on every range can be carried out in a few minutes from the front panel. Even source errors due to input bias current are taken into account by the Datron Autocal. No adjustment pots to tweek, no disassembly. In fact, you can operate your Datron DVM for five years or more without removing the covers.

Calibration of each range/function takes only a few seconds. To calibrate the 10 volt DC range, for example, press the 10 V "range" button, short the input terminal and press the "zero" button. This updates the zero calibration reference. Remove the short, apply 10 volts and hit the "gain" key. That's all it takes. And, because the calibration is not interactive, none of the other range/functions are effected. If the 10 V DC range is the only one requiring calibration, the DVM can be put back into operation immediately. Datron's Autocal let's you calibrate any or all of the range/functions as required.

Incidentally, the calibration mode is "enabled" by a key operated switch in the rear panel. The key is normally kept by a calibration or supervisory engineer to prevent unauthorized or accidental access to the calibration memory.

Another feature of Datron's Autocal is its ability to operate on the IEEE bus. In conjunction with a bus compatible calibrator, your Datron DVM can be calibrated remotely and in situ. In systems use, where DVM downtime can also mean system downtime, this can reduce to fifteen minutes or less what could otherwise take a minimum of several hours and a maximum of several days.

There are a lot of other time and money saving features of Datron DVMs such as automatic self-test, error read-out and computing capability plus a comprehensive *five year warranty* and free annual calibration for five years. These features and specifications are covered in detail in our new literature. Write for it. It's free.

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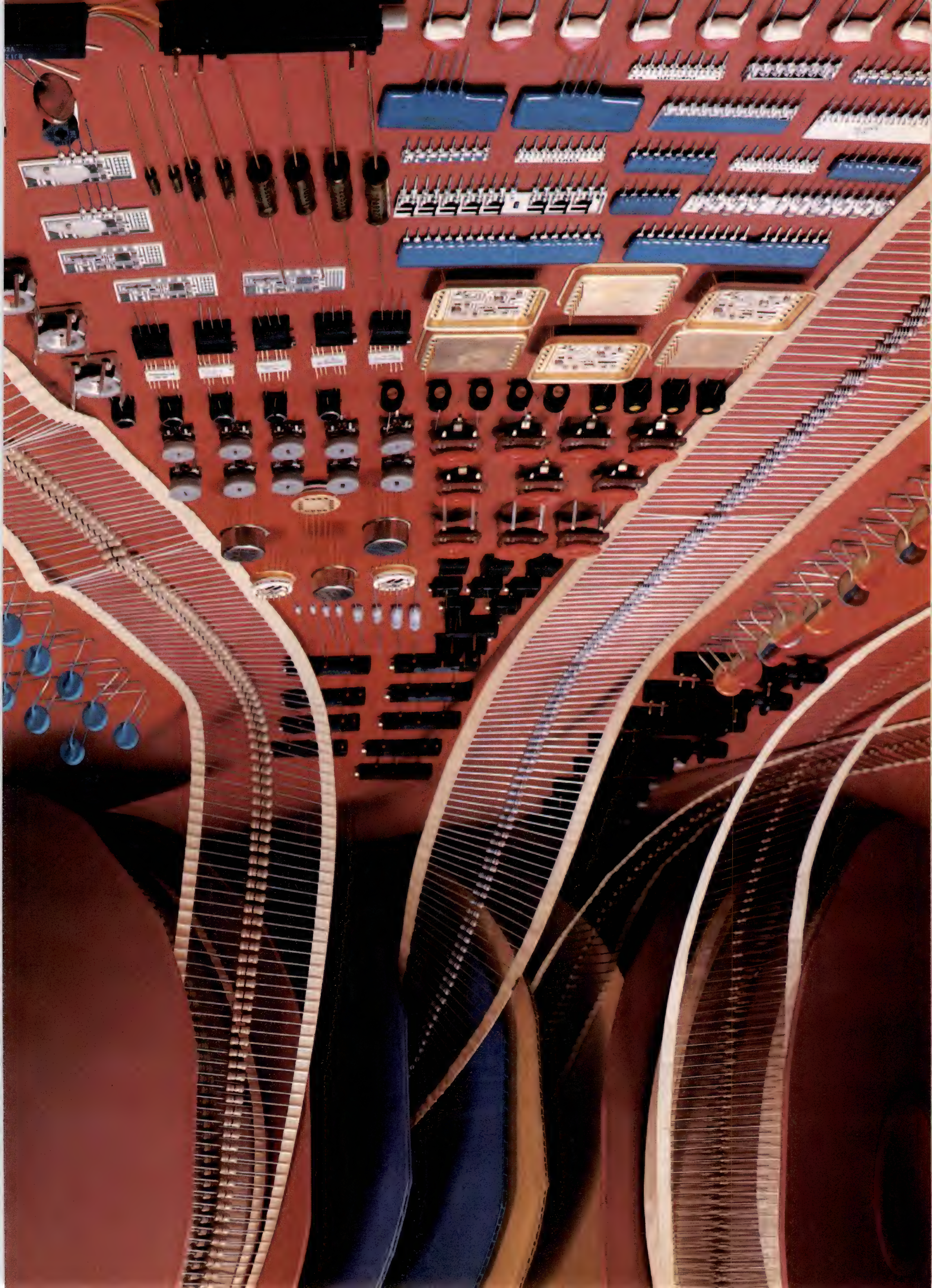
CIRCLE NO. 63



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CIRCLE NO. 64

This is an unretouched Photograph of Mepco/Electra's resistors.

Automatic tester saves space

A parallel functional tester checks out 49,920 devices simultaneously and automatically. The tester consists of a console, which takes up about 7 sq. ft. of floor space, and one to four test chambers, each of which measures approximately 10 sq. ft.

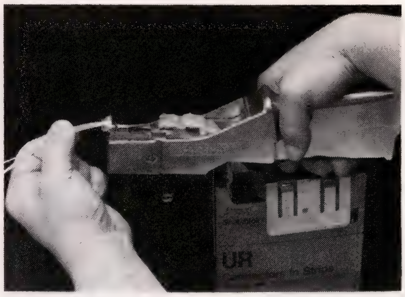
A microcomputer controls nearly all important test parameters, such as input power, dc power, stimulus clocks and test program sequences. It monitors and controls the temperature and atmosphere of the test chambers. The system also has burn-in capability.

Each test chamber can accommodate 12,480 devices, at a cost of $30 to $55 per device. The price of the complete system is about $0.5 million.

Microtest Systems, Inc., 1188 Bordeaux Dr., Sunnyvale, CA 94086. (408) 745-7000.

CIRCLE NO. 404

Splicing tool dispenses U-contact connectors



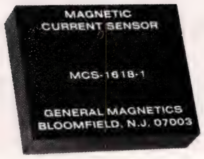
A lightweight crimping tool, the E9C-H, dispenses up to 100 U-contact connectors from a magazine carton. The carton attaches to the tool. For greater reliability, the tool does not release until a positive connection is made. an optional tool holder clamps to a bench or tool box to keep the E9C-H at a convenient height, ready to use.

3M, Dept. TL80-11, Box 33600, St. Paul, MN 55133. (612) 733-3351.

CIRCLE NO. 406

New! From...
GENERAL MAGNETICS

MCS-1610-1



MCS-1618-1

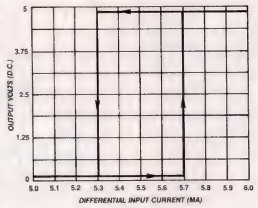
PRECISION MAGNETIC CURRENT AND VOLTAGE SENSING MODULATORS

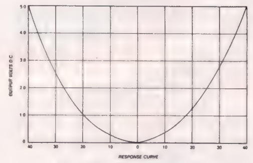
THE MOST SUPERIOR ELECTRICALLY GALVANIC ISOLATION CURRENT SENSOR AVAILABLE.

FEATURES:

- Total galvanic and high voltage dielectric isolation.
- Common mode rejection of high amplitude input AC wave forms from output signal.
- Input, output and power circuits may all be completely isolated.
- Multiple floating isolated inputs & outputs.
- Input current sensing. 0.0 to 100's of amp's, either AC or DC.
- Extremely low MV level input signals.
- Linearity 0.1% or better or logic level outputs.
- Stability over wide ambient temperature range (−55°C to +125°C)
- Capable of operation in ambients as high as +500°C and as low as −270°C.
- Virtually infinite life device–hundreds of thousands of hours of uninterrupted operation.
- Withstands high levels of nuclear radiation.
- Transfer functions may be linear, squaring, simple product or logic outputs.
- Size–MCS-1610-1-3.325″H x 2.510″W x 2.510″D
  MCS-1618-1-0.485″H x 1.800″W x 1.475″D

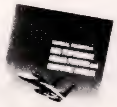
Logic Level Output





Squaring Transfer Function

THE LOGICAL SOURCE



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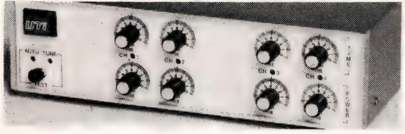
CIRCLE NO. 65

Bonder assembles multichip circuits



A four-channel ultrasonic bonding system, Model 410E, assembles multiple-chip circuits. A variety of power and time settings are offered. The unit uses a single ferroelectric transducer in stitch or multi-lead bonding. Each of the four power and time channels are pre-set by the operator. A single voltage pulse activates any channel at random. Bonding system actuation can be provided by logic circuits or by operator controlled manual switches.

UTI, 325 N. Mathilda Ave., Sunnyvale, CA 94086. (408) 738-3301.

CIRCLE NO. 396

Basic continuity tester expands to 32,768 points

A microprocessor-controlled, automatic continuity tester, CBT-126, expands in 128-point increments to a system capable of testing 32,768 points. The unit grows from a basic unit of 2048 points to provide fast, reliable testing of all cables, harnesses, wrapped-wire boards, bare PC boards and backplanes. It automatically tests for opens and shorts and clearly identifies, on a printout form, all errors by location and type of wiring faults. The system is based on a keyboard-floppy disk-CRT controller. Test programs can be quickly called up and loaded via their IDs. New diskettes can be added to keep pace with changing technology. The controller unit provides cumulative statistical data to help users track test-result history.

Sensitek, 127 Gaither Dr., Moorestown, NJ 08057. (609) 234-6300. From $2400; 8 to 13 wks.

CIRCLE NO. 397

Wrap-wire boards need no DIP sockets

Wire-wrappable boards, 4-DE2-VHF, 4-DE4-VHF and 4-DE6-VHF, are selectively loaded with screw-machined socket pins; no DIP sockets are required. The boards are fully compatible with DEC hardware and offer a continuous VHF ground plane to accommodate circuits operating at up to 500 MHz. DIPs and discrete components of any size can be intermixed on the boards. A secondary ground plane and multiple power buses are available. All holes are plated-through for circuit reliability. Boards can be stacked on 1-in. spacing.

Hybricon, 410 Great Rd., Littleton, MA 01460. (617) 486-3174. $146.95 to $395.00; 2 to 3 wks.

CIRCLE NO. 398

Beveling machine boosts production rates

An abrasive air-jet beveling machine, the Swam Model B, uses two rotary vacuum chucks to increase production rates. While one chuck is positioned in the cut and bevel position, another chuck is under an optical comparator to align the next silicon slice. At the end of a bevel cycle, the chucks change places by indexing 180°. The machine can make two bevels simultaneously.

Crystal Mark, 613 Justin Ave., Glendale, CA 91201. (213) 240-7520.

CIRCLE NO. 399

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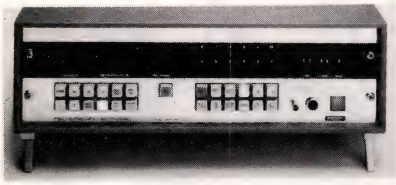
Beta backscatter tester measures platings

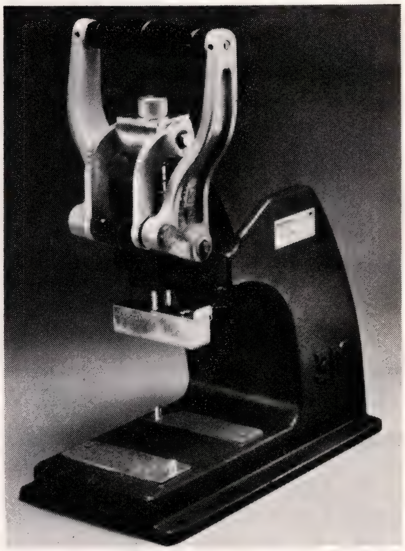


A beta backscatter instrument, the Fischerscope Beta 2050, makes accurate, nondestructive measurements of coating and plating thickness. The system is effective with gold, silver, rhodium, copper and a variety of metallic and nonmetallic materials. A software program module records measurements and evaluates the results for a reliable assessment. A screen on the instrument's panel prompts an operator and responds to each step. The tester can be equipped with an alphanumeric printer to provide a permanent record of all measurements.

Fischer Technology, 750 Marshall Phelps Rd., Windsor, CT 05095. (800) 243-8417. 2 wks.

CIRCLE NO. 328

Assembly press adjusts for snug fit



A knurled knob on the Model 3640 assembly press allows correct adjustment of "shut heights" for terminating various Scotchflex connectors to ribbon cable. A user places the shut height gauge in position and adjust the height of the pressure platen using the knurled knob. Changes can be made within seconds. In addition, a spring, in line with the press shaft, improves assembly times by returning the shaft to the fully open position after each use. Model 3640 can be bench-mounted. Its locator plate for connector and cable positioning may be readily changed to facilitate cable access from the right, left or front.

3M, Dept. EP9-36, Box 33600, St. Paul, MN 55133. (612) 733-1110.

CIRCLE NO. 329

$24.00

Cadillac quality... Ford prices

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5V at 3A with OVP.

New Value Line open frames

- 115/230 vac input.
- Shielded transformer
- 3-year warranty.
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- Barrier terminals.
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Model VQ5-3C

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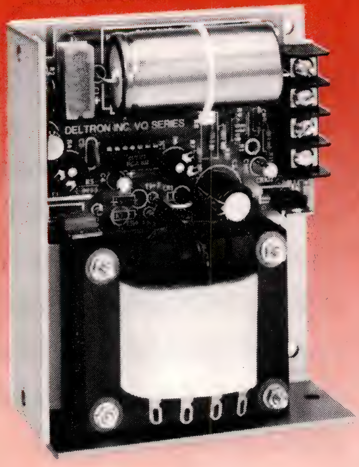
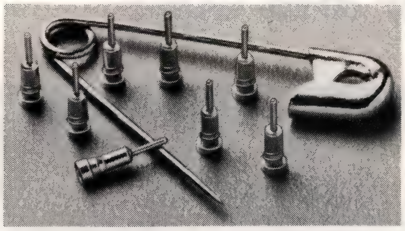
AC 32

CIRCLE NO. 66



Combo jack/pin accepts 0.018-in. pins or IC leads

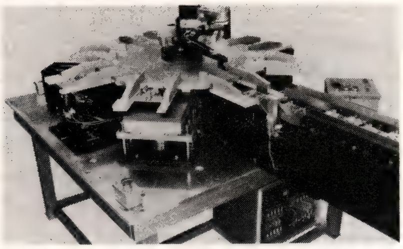


A combination jack and pin, Part No. 450-0028, accepts 0.018-in. pins or rectangular IC leads. The jack uses four, beryllium-copper contact leaves with 30 μin. of gold plating. The machined brass body comes with gold or tin plating. The solder-tab portion is 0.02-in. in diameter. After mounting the contract in a PC board, any device can be firmly held. When pressed into a 0.055-in. hole on a 0.125-in. board, the contact provides an extra low profile. Overall contact length is 0.29 in.; body diameter, 0.053 in.

Cambridge Thermionic, 445 Concord Ave., Cambridge, MA 02238. (617) 491-5400.

CIRCLE NO. 330

Automated board tester runs at production rate

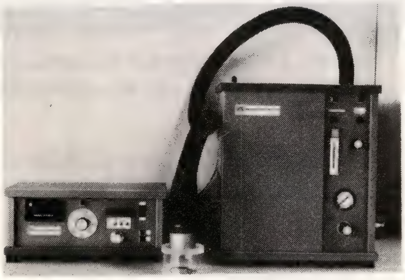


An automatic PC-board tester, Model 4400, handle and tests boards at high production speeds. Up to 50 boards per minute, or approximately 24,000 boards each 8-h shift, can be checked, depending on test time and various other factors. Unlike earlier models, the Model 4400 moves boards from a feed conveyor through its test cycle on a rotary indexed multi-station table. Computerized testing, supplied by the manufacturer or through an interface adaptor to the user's computer/tester, is possible. Other options allow configuration of the board tester for various test requirements, such as bare board, stuffed board, continuity, high-voltage leakage, functional, incoming pass-fail, automatic component adjust, accept/reject print, etc.

Electro-Mechanical Laboratories, 2 Oakwood Ave., Norwalk, CT 06850. (203) 847-0900.

CIRCLE NO. 331

Air jet cycles parts for temperature tests



A table-top system, the Air-Jet, provides a method of controlling the temperature of individual chips, boards and hybrids while they are being actively tested by automated test equipment. A stream of temperature-controlled air can by cycled from −60 to +150 C in less than 30 s, permitting rapid temperature change of components. A 40-pin plastic DIP, for example, can achieve a set temperature in less than 60 s with a control accuracy of ±0.5 C. A nozzle is located at the tip of an insulated flexible hose for convenient placement of a component at a remote location. A variety of replaceable shrouds are available to enclose all component configurations. An air or gas source is required.

FTS Systems, P.O. Box 158, Rt. 209, Stone Ridge, NY 12484. (914) 687-7664.

CIRCLE NO. 332

Grayhill's New SEALED KEYBOARDS

SPILLPROOF! TACTILE FEEDBACK! LONG LIFE!

You can hear and feel the actuation in Grayhill's new Series 88 sealed keyboards! Offered in 3x4 and 4x4 button configurations with ½" button centers, these keyboards have a graphic overlay which seals the keyboards and contacts, resisting contaminants, making the surface washable, and suitable for outdoor use. There are a variety of standard legend colors and formats, and custom nameplates are available, too.

Grayhill Series 88 keyboards are flange mounted; special optional gaskets seal the flange surface for either front panel or sub-panel mounting.

Logic-compatible Series 88 keyboards are offered with matrix, 2 out of 7, 2 out of 8, or single pole common bus circuitry. Snap dome contact system provides positive audible and tactile feedback to the operator and a 3,000,000 life cycle per button!

Engineering data, prices, and full color graphics are yours for the asking in Bulletin No. 297.

Grayhill INC

561 Hillgrove Avenue • LaGrange, Illinois 60525
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CIRCLE NO. 67

CUT SYSTEM COSTS WITH HUMPHREY'S COMPLETE LINE OF LOW COST GYROS

FOR PRECISE GUIDANCE AND CONTROL OF EXPENDABLE DRONES, OR SOPHISTICATED RPV'S

Humphrey's fully qualified line of gyros lets you select the right model to meet your exact mission requirements. Production models are available with AC or DC motors, and potentiometer pickoffs for a wide variety of autopilot systems. They're in production for major short, medium and long range flight programs. The Humphrey line includes:

- Spring driven - instant start gyros.
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For full information write: Humphrey, Inc., 9212 Balboa Ave., Dept. ED580, San Diego, California 92123
Phone (714) 565-6631

WRITE FOR GYROSCOPE SELECTION GUIDES . . .
with specifications and dimensional drawings on Humphrey's standard line of gyros.

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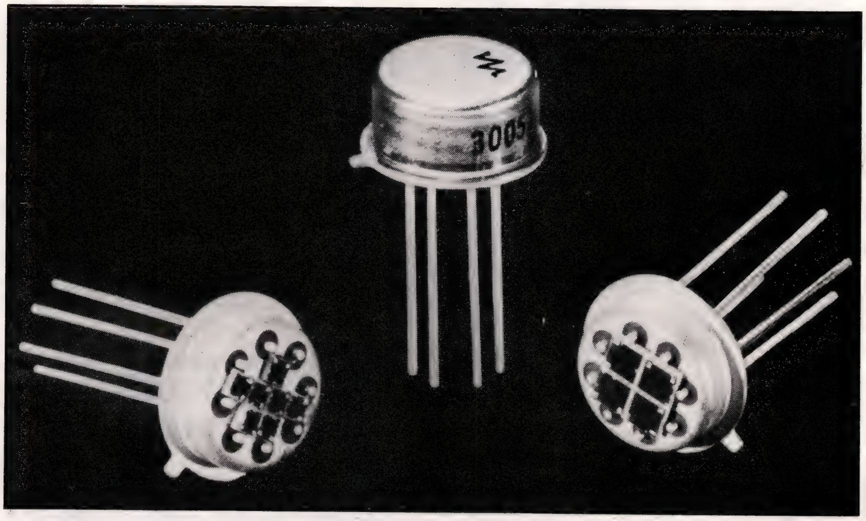
CIRCLE NO. 68

COMPONENTS

Precision resistors pack smaller size and cost



Typically, a TO-99 can will house four precision resistors (right); however, seven resistors may be easily accommodated (left).

With specialized processing and miniaturization reducing both the size and cost of Vishay's Bulk Metal resistors, several resistors can be packed into a single space-saving mini-DIP or TO-99 package—with cost savings of 30 to 50% over separate components. Such networks are especially useful on microprocessor boards and other high-speed logic circuits where signal levels are small and where precise voltage drops are required.

Resistance values for the individual network parts range from 5 Ω to 25 kΩ, with a choice of circuit configurations. Power-handling capabilities for each resistor range from 0.05 to 0.1 W.

Absolute tolerances for the precision networks can be specified to within ±0.02% (±0.01% tracking), with a load-life drift of less than 0.05% total resistance change after 2000 hours at 70 C and full rated power. Standard TCR is within ±5 ppm/°C (±3-ppm/°C tracking), though tolerances as tight as ±0.5 ppm/°C can be specified for the entire mil-spec range (−55 to +125 C).

Metal-packaged TO-99 networks will typically configure four resistor chips within a small, 0.335-in.-diameter can, which sits less than ¼ in. above the circuit board. DIP-packaged networks will typically configure eight resistor chips in a low-profile, 16-pin package on 0.300 × 0.100-in. centers.

Prices for the Bulk Metal networks will vary according to resistance value, circuit configuration, package style and quantity. For example, a network housing eight Bulk Metal resistors in a 16-pin DIP—with each resistor rated for a TCR of 5 ppm/°C over the entire mil-spec range—will cost roughly $45.00 each in 100-piece lots. A TO-99 package containing four similarly spec'd resistors will cost about $16.00 in the same quantities. Delivery is stock to 12 weeks.

Vishay Resistive Systems Group, 63 Lincoln Highway, Malvern, PA 19355. Tony Trianello (215) 644-1300.

CIRCLE NO. 308

© 1980 Spectronics

We just coupled our Sweet Spot™ LED to this innovative AMP connector and gave it the highest fiber driving power it's ever had.

Of course, its low profile and easy coupling advantages are still the same. But the Sweet Spot gives it much more design flexibility.

For example, now it can be used with practically any cable. And coupled with the widest selection of optical receivers yet. Everything from high speed PIN diodes to low speed high sensitivity detectors. Plus, it provides the simplest circuit interface and most practical opto-mechanical interface available. Here are some Sweet Spot detector options:

SPX 4690 Medium Speed Detector

This high sensitivity detector utilizes an on-chip transistor preamplifier to simplify circuit design and has a broad operating bias range of up to 15V.

SPX 4691 Sweet Spot PIN Diode

With a response time of one nanosecond and 5V operating bias, this high speed detector opens the door to hundreds of new possibilities.

SPX 4692 High Sensitivity PIN Diode

For interfacing large core fibers of 200 microns or more, this 15V PIN diode provides a performance level that will simplify many applications.

SPX 4693 Schmitt Detector

This fully integrated detector/interface circuit represents a major technology breakthrough. It's TTL and CMOS compatible and features a Schmitt Trigger output with total on-chip conditioning circuitry.

These are just a few of the endless new design solutions created by Sweet Spot LED power.

TYPICAL TRANSMISSION DISTANCE (METERS)

SPX 4689*(SWEET SPOT LED) WITH:	DUPONT PFXP140	DUPONT PFXPIR140	SIECOR 142	SIECOR 133	ITT T433	MAXIMUM DATA RATE (Mb/s)
SPX 4690*– MEDIUM SPEED DETECTOR	10	40	1400	400	500	1
SPX 4691*– SWEET SPOT PIN DIODE	10	35	—	650	950	30
SPX 4692*– HIGH SENSITIVITY PIN DIODE	16	60	2400	1300	1900	10
SPX 4693*– SCHMITT DETECTOR	13	35	1700	700	1000	0.1

*Part number describes component/connector assembly

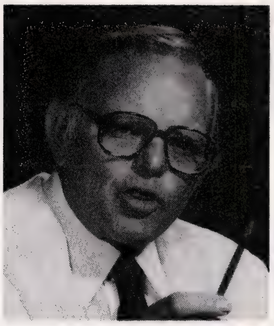
Solutions that, coupled with AMP's sophisticated connector technology, bring fiber optics out of the lab — once and for all.

Contact Spectronics for more information at 830 East Arapaho Road, Richardson, Texas 75081. Telephone (214) 234-4271.

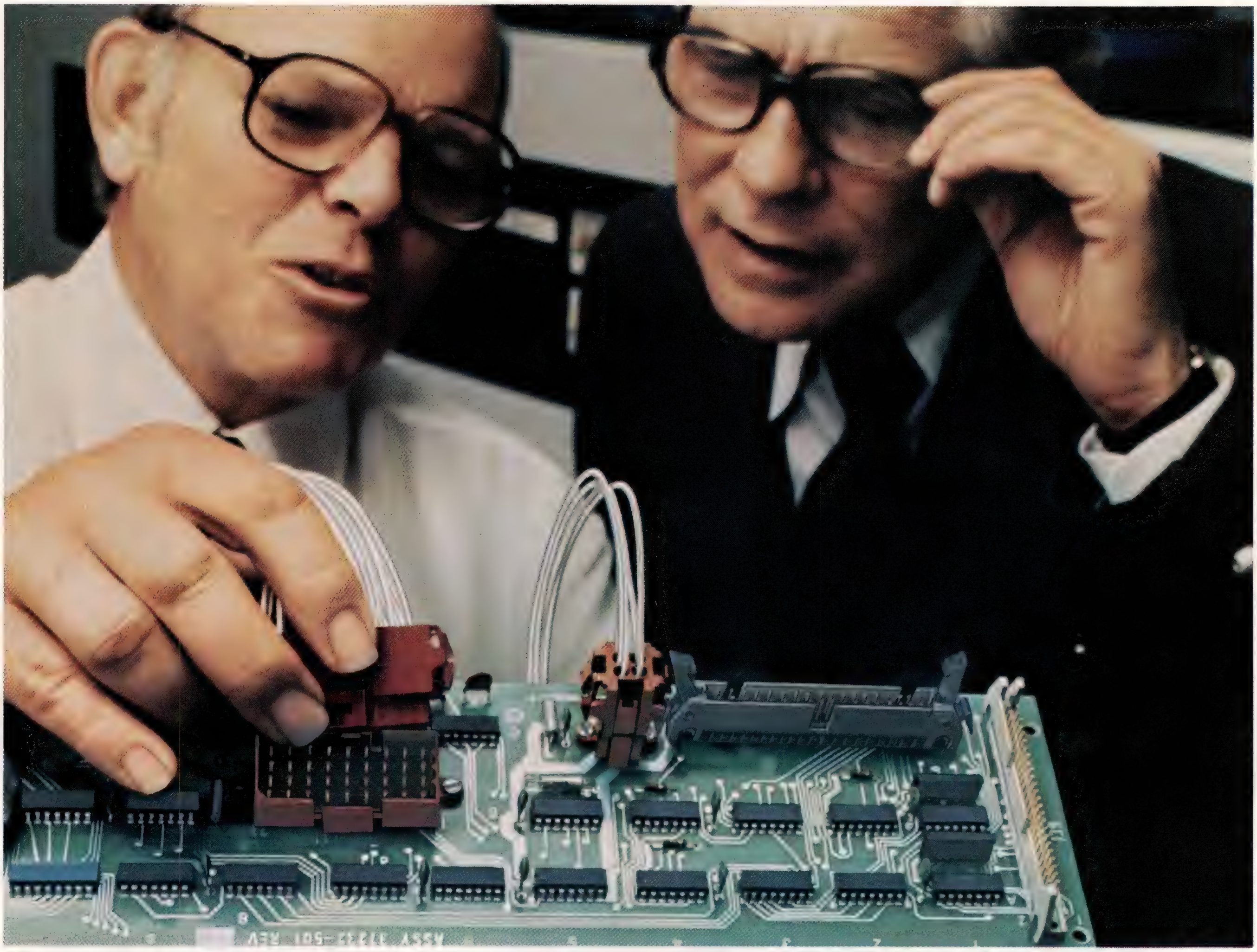
Spectronics
A division of Honeywell

Light years ahead.

CIRCLE NO. 69



"I need a cost-saving connector I can apply simply, anywhere in the world. And that's a perfect description of the AMP Metrimate line."



Metrimate is our internationally accepted rack and panel connector. Internationally accepted because no matter what standard of approvals you go by—UL, CSA, or VDE, Metrimate meets or exceeds them all.

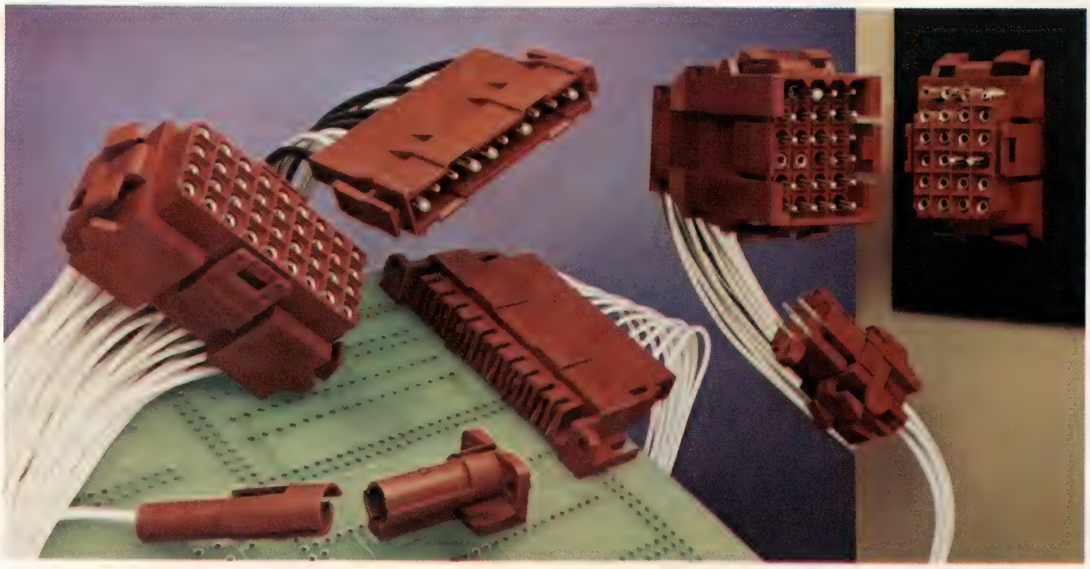
Internationally accepted because Metrimate housings and contact spacings are designed to true metric dimensions.

And, because AMP can supply these connectors to you anywhere in the world, along with the technical service and support to back them up.

But the first description—"a cost-saving connector you can apply simply" —really tells the whole story. Because every time you use a Metrimate connector, it saves you money. With features like low cost thermoplastic housings, shield accessories, strain reliefs, and the elimination of mounting hardware. And the incredible variety of automatic contact application equipment available to you. Now, with the addition of a new commoning power distribution header, Metrimate is cost effective in an even wider variety of applications.

Of course, descriptions only go so far. It's the application that counts. So to find out how you can start saving money with the connectors you can apply anywhere, call or write us for more information.

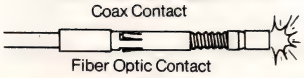
AMP has a better way.



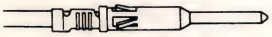
Some facts worth knowing about AMP Metrimate Connectors

Description: Part of AMP's exclusive Multimate Family that accommodates common contacts in a variety of connector housing styles and saves on both tooling and inventory costs.

Coax Contact


Fiber Optic Contact

Signal Contact


Power Contact

Voltage rating: 380 VAC, 450 VDC (VDE), 600 VAC (UL); 250 VAC (CSA).

Dielectric strength: 1500 volts rms at sea level.

Temperature: −55°C to +105°C.

Current rating: Signal and Power Contacts; 13A max. per contact (limited only by connector block working temperature).

Insulation resistance: 5000 megohms, min.

Contact resistance: 5.5 milliohms, max.

Durability: 250 cycles, tin-plated contacts, 550 cycles, gold-plated contacts.

Where to telephone: Call the Metrimate Information Desk (717) 780-8400.

Where to write: AMP Incorporated, Harrisburg, PA 17105.

AMP is a trademark of AMP Incorporated.

AMP

CIRCLE NO. 70

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CIRCLE NO. 71

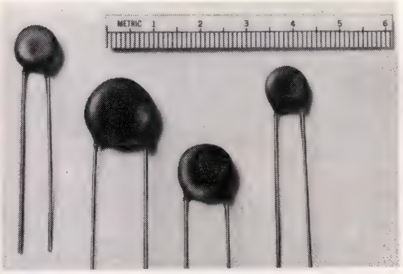
Transducer generates low-frequency audio

A piezo-ceramic audio transducer, Series X-60, generates super-low frequency audio over a 2.3 kHz range. The device accepts a 5 to 15-V dc input to generate a typical sound pressure level, at 1 ft, of 75 to 88 dBa. Average current drain is 2 to 11 mA. Two PC pins are supplied and the unit is wave-solderable.

Projects Unlimited, 3680 Wyse Rd., Dayton, OH 45414. (513) 890-1918.

CIRCLE NO. 333

Positive tempco resistor protects circuits

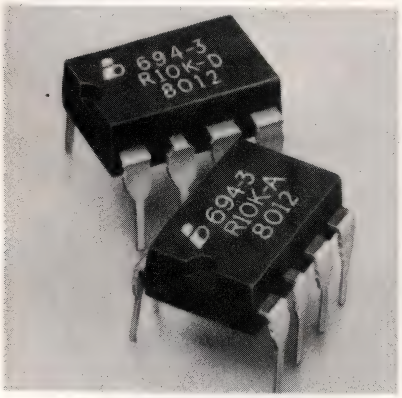


A positive tempco resistor, called a Posistor PTH-60 series, protects a variety of circuits against overcurrent conditions. When connected in series between the protect circuit and a power source, Posistors remain in a low-resistance state. When excessive current flows through the devices (a preselected threshold level) self-heating of the resistor causes its resistance to rise, thus limiting current flow to a safe level. Once power is removed, the device cools and resistance returns to its original low value. Posistors are offered in resistance from 10 to 75 Ω and with maximum current rating of from 0.3 to 1.2 A. Maximum diameters range from 0.323 to 0.595 in.

Murata, 1148 Franklin Rd., S.E., Marietta, GA 30067. (404) 952-9777.

CIRCLE NO. 334

Resistor network tracks well over temp range



A thin-film network in an 8-pin DIP, Model 694, allows resistors to track within 5 ppm/°C over a −55 to +125 range. The DIP contains four isolated precision resistors. Four standard accuracies of absolute and ratio tolerances range from 1 to 0.05%.

Beckman Instruments Network Products, 2500 Harbor Blvd., Fullerton, CA 92634. (714) 773-8326. $1.00 to $1.50 (1000 qty).

CIRCLE NO. 335

Monolithic quad diodes assure close matching

Each diode in a series of Schottky-barrier diode quads is closely matched to assure close matching of capacitance, forward voltage and series resistance characteristics. The devices can be used as double-balanced mixers or in phase detectors, AM modulators and pulse modulators. Beam lead construction minimizes parasitic capacitance, as well as lead inductance. This permits interconnection of the diodes into rings and other configurations at the wafer level. Three barrier levels are available: low (MA-40430 Series), medium (MA-40440 Series) and high (MA-40490 Series).

Microwave Associates, South Ave., Burlington, MA 01803. (617) 272-3000.

CIRCLE NO. 336

High-voltage transistors work in fast switchers

Two high-voltage power transistors, TIP701 and TIP702, find use in fast switching-mode power supplies. TIP701 is rated at 400 V (collector-to-emitter) and 800 V (collector-to-base). TIP702 handles 450 V from collector to emitter and 950 V from the collector to base. Continuous collector current rating is 3 A for both devices. Maximum voltage rise time is 500 ns at 100 C. Reverse-bias safe operating area is 400 V at 2 A for TIP701; 450 V at 2 A for TIP702.

Texas Instruments, P.O. Box 225012, Dallas, TX 75265. (214) 238-2011. $2.58 (TIP701); $3.06 (TIP702) (100 qty); stock.

CIRCLE NO. 337

Turn On Our Dip Switches. Turn Off Your Switch Problems.

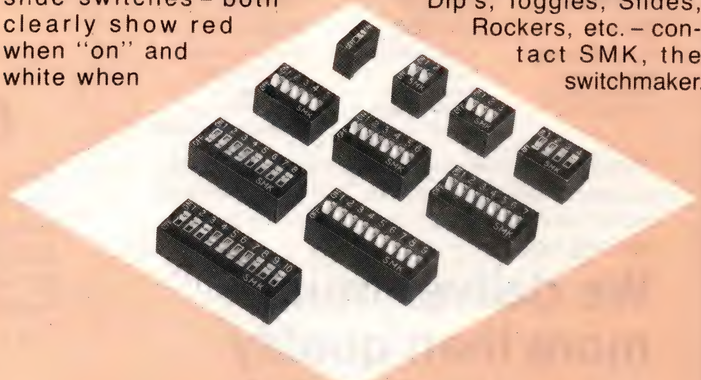
When you're looking for Dip Switches, remember this: every SMK Dip Switch is quality built with important design features that can solve your switching problems and save you money.

Only SMK Dip Switches are designed with a double-sided clip-type wiping contact that provides self-cleaning action for higher reliability and longer life. Every SMK Dip Switch features sealed and oven-cured construction to prevent flux contamination during wave soldering.

And now you have a choice between our standard toggle-lever slide-switches and our new low-profile flush-lever slide-switches – both clearly show red when "on" and white when "off." What's more, each switch position has four positive detents to ensure excellent shock and vibration characteristics.

Both types are available in 1 to 10 switch positions. The flush-lever version can be taped and sealed on the top to protect against contamination during cleaning. Plastic caps are also available to protect pre-programmed switch settings. Available in SPST configurations, SMK's slide-type Dip Switches are rated at 24V DC at 300mA switching, resistive load, and will operate from −20°C to +87°C.

Want to know more? For any kind of switch– Push Buttons, Dip's, Toggles, Slides, Rockers, etc. – contact SMK, the switchmaker.

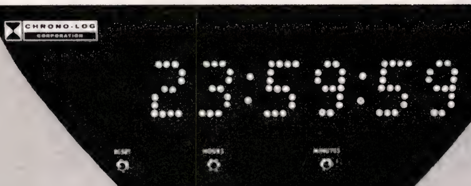


SMK

SMK Electronics Corporation of America
113 E. Savarona Way, Carson, Ca. 90746 · Phone (213) 770-8915
"SEE US AT ELECTRO BOOTH 2211"

CIRCLE NO. 72

DIGITAL CLOCKS



Thousands of Configurations at Off-the-Shelf Prices. Options Include:

- Time ranges from milliseconds to years
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- ASCII output for RS232C ports
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- Master Digital Time Systems

Chrono-log Corporation, 2 West Park Road,
Havertown, Pa. 19083 Phone: (215) 853-1130

CHRONO-LOG CORPORATION

CIRCLE NO. 73

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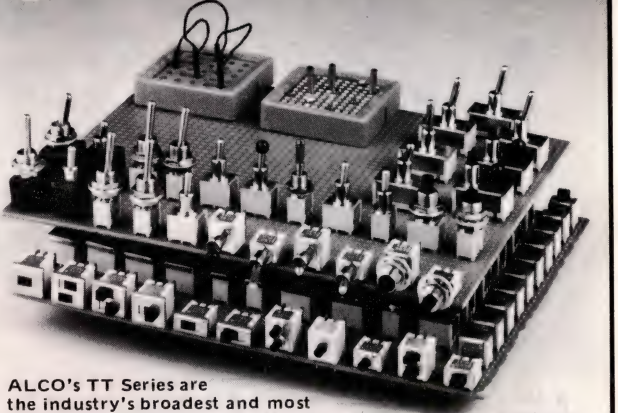
world's smallest pc mountables



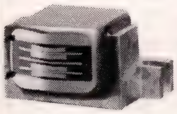
ALCO's TT Series are the industry's broadest and most unique selection of sub-miniature toggle switch products, encompassing mating slides and pushbuttons. Design stress is toward switch products fitting a 0.1" PC grid standard. The TT Series were developed with printed circuitry in mind having gold plated contacts and terminals as standard, proprietary preformed terminals and a constant height level to fit between PC boards placed on 1/2" centers. Sub-miniature switches decreased in size without compromise in quality.

ALCOSWITCH®

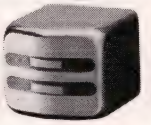
ALCO ELECTRONIC PRODUCTS, INC. a subsidiary of Augat®
1551 Osgood St., No. Andover, MA. 01845 USA
Tel: (617) 685-4371 TWX: 710 342-0552

CIRCLE NO. 75

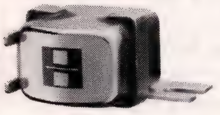
We'll help you get a head (and stay ahead!)



3Q1-
4-track/4-channel cassette head ..
Precision Mount,
(Azimuth ± 6')



WP-1D2
4-track/2-channel
Extended low-frequency response head for .250" tape



3D7-
2-track/2-channel cassette head,
Universal Industrial mount,
Exceptionally versatile.

Three typical Vikron magnetic heads that come equipped with total service. That simply means we're not done helping you until you're done needing help.

We deliver much more than quality magnetic heads!

Call or write for complete and free information.

VIKRON
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P.O. Box 737, 520 Blanding Woods Rd. S., St. Croix Falls, WI 54024

CIRCLE NO. 74

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Need to contact the local rep for a company whose products you are evaluating? Tough to find who's on first for a specific manufacturer? Unless you use ELECTRONIC DESIGN's GOLD BOOK. With over 60,000 sales outlet listings—including reps, sales offices and distributors, organized by manufacturer—you'll surely find the right rep to rap with. Try it. You'll save a lot of time.

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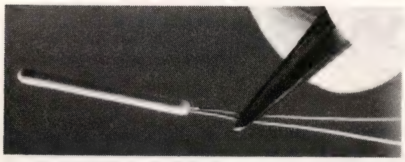
Small platinum element senses temperature



A platinum resistance thermometer, Model S200, measures only 0.04 in. diameter and 0.45-in. long. The ceramic supported element can be used "as is" or assembled into a protective metal case. Standard resistance values are 100, 200 or 500 Ω at 0 C. Resistance ratios from 0 to 100 C are 1.385 or 1.392. Stability and repeatability of measurement are ±0.1 C or better over the entire temperature range.

Minco Products, 7300 Commerce Lane, Minneapolis, MN 55432. (612) 571-3121.

CIRCLE NO. 338

Tiny solenoid fits into TO-5 case

A tiny solenoid, small enough to fit inside a TO-5 transistor case, generates high forces for short periods. Designated the TO-5, the solenoid can be held in its actuated position by following a pulse with a low-level holding voltage. At the average recommended power of 3/4 w, the component generates forces from 1 to 10 g with plunger travel from 0.1 to 0.05 in. By adjusting off-time with impulses up to 200 W to maintain an average of 3/4 W, the TO-5 can generate forces up to 50 g for a plunger travel of 0.1 in. The unit is offered for intermittant or continuous duty. Coil voltages for the intermittant-duty version are 3, 6, 12 or 24 V dc. Continuous-duty models have voltages of 0.25, 0.5, 1 or 2 V.

Artisan Electronics, 5 Eastmans Rd., Parsippany, NJ 07054. (201) 887-7100.

CIRCLE NO. 339

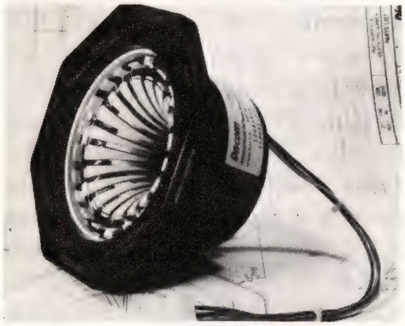
Loop-sense relays meet FCC specs

Series 1001 loop-sensor relays use two balanced windings to maintain longitudinal balance in telephone tip-and-ring circuits. the parts detect the "off-hook" condition of telephone sets. Coil resistance is 25 Ω; the must-operate current, 19 mA. Contacts are rated at 1 A at 300 V dc. Maximum coil power rating is 750 mW. The relays are available with two break and two make contact sets. The relays are packaged in sealed DIPs with terminals spaced on a 0.1 × 0.3-in. grid for flow-soldering or to plug into an IC socket.

Electrodyne, 11200 S.E. 21st St., Milwaukie, OR 97222. (503) 654-0711. $8.90 (1000 qty).

CIRCLE NO. 340

Deflection yokes keep display geometry sharp



Wide-angle deflection yokes, Discom SY110 Series, offer consistent part-to-part uniformity of field and geometry to eliminate recorrection at an OEM production site. A patented stator configuration minimizes spot defocusing and keeps geometry square within 1% typical. The 110° yokes are available with inductances from 22 μH to 35 mH and a typical deflection energy of 1800 μJ for ±49° at 16 kV.

Display Components, 550 Newton Rd., P.O. Box 488, Littleton, MA 01460. (617) 486-3594. From $25 (OEM qty).

CIRCLE NO. 341

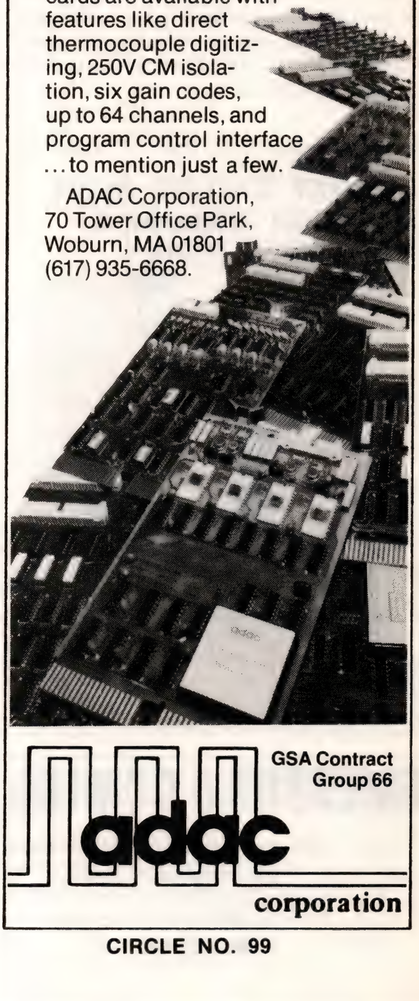
Nobody else has LSI-11 and LSI-11/2 cards like these.

Our digital cards are loaded with unique features such as the ability to use I/O lines as either inputs or outputs in increments of eight, up to 64 TTL inputs or outputs interfaced directly to the LSI-11 bus, the ability to detect contact closures on discrete input lines, and discrete latched outputs with the capability to drive high current incandescent lamps.

The Bus Repeater Card accommodates more devices than the basic bus can handle. The Bus Translator Card allows LSI-11 peripherals to operate with a Unibus CPU.

Both high level and low level analog cards are available with features like direct thermocouple digitizing, 250V CM isolation, six gain codes, up to 64 channels, and program control interface ...to mention just a few.

ADAC Corporation,
70 Tower Office Park,
Woburn, MA 01801
(617) 935-6668.

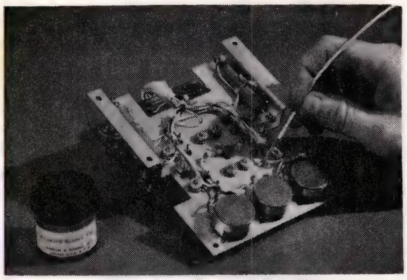


GSA Contract
Group 66

adac
corporation

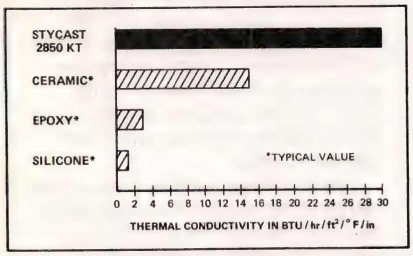
CIRCLE NO. 99

LOW COST PLASTIC REPLACES HOT SOLDER



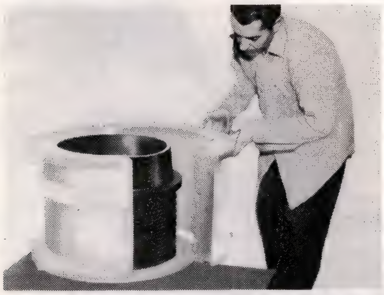
ECCOBOND® Solder 72-C is an electrically conductive (0.01 ohm-cm) adhesive which costs only one-fourth as much as siliver-filled plastics, yet it cures at low temperature; adheres to Al as well as Cu; resists corrosion without special coating. Great for electronic production.

HIGHEST THERMAL K ENCAPSULATING RESIN



STYCAST® 2850KT is a product of advanced materials technology. It has thermal conductivity 10 to 20 times that of materials commonly used for electronic encapsulation; yet it is flowable, maintains shock and vibration protection and excellent electrical grade insulation. A "castable heat sink."

EPOXY CASTING RESIN HIGH THERMAL K LOW SHRINK



STYCAST® 2850 FT has properties dear to the heart of an engineer: volume resistivity 10^{14} ohm-cm; thermal conductivity 10.7 BTU/ft^2/hr/°F/in; thermal expansion 10^{-5} per °F. Easy-pour; RT or oven cure; use from cryogenic region to 400°F. Giant castings a specialty.

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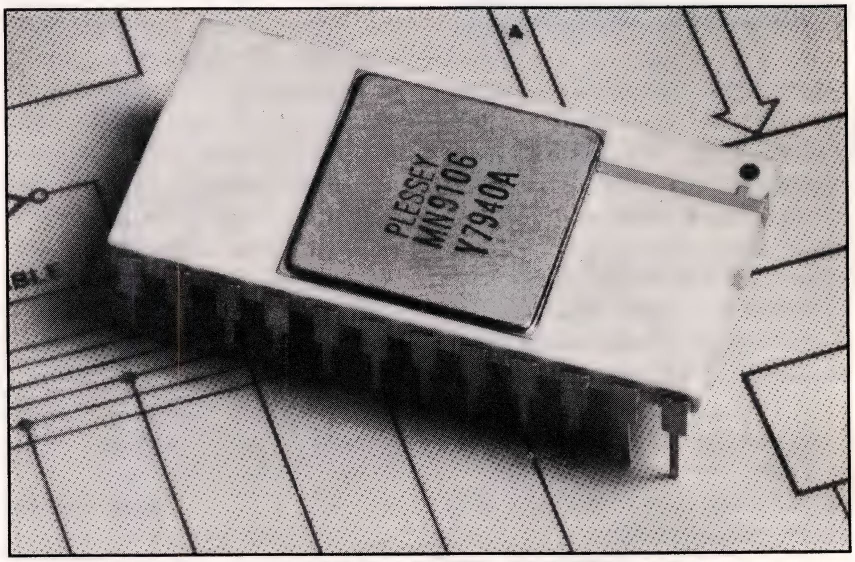
Telephone (617) 828-3300
CIRCLE NO. 77

Nonvolatile counter needs only one supply



Housed in a 24-pin DIP, six-decade MNOS up-counter will retain its count in the absence of applied power over the temperature range of −40 to +70 C.

Counters with nonvolatile memories are not new, but Plessey's latest is unusual: It powers a 25-bit MNOS memory with no need for a special external supply. Housed in 24-pin DIPs, the six-digit μp-counter operates from a standard 12-V supply (or a split +5/−7-V supply) and generates all other voltages on-chip, with the aid of an external capacitor. Data retention of the stored counts is guaranteed for a year, between −40 and +70 C.

Simple to interface to both TTL and CMOS logic, the counter comes in three versions: the MN9106, which counts up to 999999; the 9107, which counts 99 hours, 59 minutes and 59 seconds; and the 9108, which counts up to 9999 hours and 59 minutes.

Each counter can handle frequencies from dc to 200 kHz and has leading-zero and full blanking capabilities. The display outputs consist of seven multiplexed segment-driving lines, six digit-strobe lines and an overflow-indicator line. The multiplexed lines are scanned by an internal oscillator that may be overridden by an oscillator signal applied to the scan input line.

The segment and overflow output lines can handle currents up to 15 mA. The digit strobes, however, are limited to 5 mA, so they require external transistors when driving light-generating displays. The multiplexing scanning rate is controlled by an external capacitor; typically, a 0.1-μF capacitor will yield a 1-kHz rate. Alternatively, externally generated scan frequencies up to 25 kHz may be utilized.

Operating from a single 12-V supply, the counters draw a maximum of 22 mA. All three versions are available in both plastic and ceramic DIPs and sell for $15 each (plastic) when purchased in 100-piece lots. Delivery is from stock.

Plessey Semiconductors, 1641 Kaiser Ave., Irvine, CA 92714. Bob Greenwood (714) 540-9979.

CIRCLE NO. 305

8-k Schottky PROMs access in 60 ns

Electrically-programmable Schottky ROMs, Am27S180 and Am27S181, provide a maximum access time, over the commercial temperature range, of only 60 ns. The devices are organized in a 1024 × 8-bit configuration and are offered in open-collector (Am27S180) or three-state (Am27S181) output versions. The memories require a single 5-V supply and typically consume 600 mW. A platinum-silicide fusible link is used at each memory location storing a logic LOW, Active loading of all critical ac paths, regulated by a built-in temperature and voltage compensated bias network, provides good parametric performance of military supply and temperature ranges.

Advanced Micro Devices, 901 Thompson Pl., Sunnyvale, CA 94086. (408) 732-2400. From $33.35 (100 qty). **CIRCLE NO. 342**

Hybrid interfaces avionics to 1553 bus

A data bus transceiver for the MIL-STD-1553A or B data transmission systems, interfaces avionic subsystems and the bus. The thick-film hybrid comes in a hermetically sealed, 24-pin DIP measuring 1.25 × 1.25 × 0.18 in. A receiver section accepts Manchester II differential data from a transformer, coupled to the data bus, and produces a biphase TTL signal at the output. A multipole, low-pass filter improves the s/n ratio. A transmitter section accepts complementary TTL data and produces a 30-V nominal pk-pk differential signal across a 140-Ω load at the output.

Aeroflex Laboratories, S. Service Rd., Plainview, NY 11803. (516) 694-6700. **CIRCLE NO. 343**

MULTIBUS compatible data acquisition and control systems.

The ADAC 700 Series of data acquisition systems plug directly into the MULTIBUS of single board computers from Intel and National. The 710 Series is the first low level analog to digital system available that includes such unique features as the capability to withstand common mode voltages of up to 250V while digitizing low level outputs from bridges, thermocouples and other low level transducers. A software programmable gain amplifier with optional cold junction compensation circuit can be programmed on a channel to channel basis. The low level analog to digital card and low level multiplexer expander card can be supplied with either 8 or 16 differential inputs per card. Resolution is 12 bits.

The 735 A/D high level analog to digital series is supplied with 16 to 64 single ended or pseudo differential inputs. It also is jumper selectable for 8, 16, or 32 differential analog inputs. The inputs can be either voltage or current loop. The 735 A/D features a 12 bit high speed analog to digital converter with throughput rates of 35 KHz basic and 100 KHz optional. The series include bus interfacing with a software selection of program control/program interrupt and a jumper selection of memory mapped I/O or isolated I/O. Up to 2 channels of 12 bit digital to analog converters can be supplied.

The extensive series of MULTIBUS compatible analog I/O boards is further complemented by the 735 DAC Series. They are supplied with up to 4 channels of 12 bit digital to analog converters, MULTIBUS interfacing, 2 scope/recorder pen control circuits, 8 discrete digital outputs with 8 high current sinks, 8 discrete digital inputs, and memory mapped or isolated I/O interfacing. Optionally available are third wire sense for ground noise rejection and 4 to 20 ma current loop outputs.

Send for full technical data:

adac
CORPORATION
70 TOWER OFFICE PARK • WOBURN, MA 01801 • 617-935-6668

CIRCLE NO. 78

No one portable everyone's needs.

So we built 21.

Everyone's needs are different. Some want the same versatility in the field they get from a bench model in the lab. Others are more concerned about weight. Some require basic performance models at an economical price. Tektronix offers a selection of 21 portable scopes — 15 real-time and 6 storage models — to satisfy just about everyone.

Take your pick. You can't beat our 400 Series when it comes to high performance. Choose from 9 models ranging in bandwidth from 50 MHz to 350 MHz. All under 26 pounds (11.8 kg). Five with an optional DMM and delta time read out.

If you're looking for a battery-powered model that fits into a briefcase or toolbox, there's our 200 Series. Bandwidths to 5 MHz. Weights less than 3.7 pounds (1.7 kg).

In between, there's the compact 300 Series, with bandwidths to 35 MHz. Each scope weighs less than 11 pounds (5.0 kg). And finally, we offer the low cost T900 Series.

Our worldwide service team goes where you go. We're with you all the way, with more than 500 service personnel at 46 Tektronix centers in the U.S.A. and hundreds of Tektronix-supported service engineers in over 50 other countries to calibrate and maintain your Tektronix scope.

So let us show you the model that's right for you. Simply contact your Tektronix Sales Engineer. He'll arrange for a demonstration of our portable or laboratory oscilloscopes. And for our latest portable oscilloscopes brochure, write: Tektronix, Inc., P.O. Box 1700, Beaverton, OR 97075. In Europe: Tektronix International Inc., European Marketing Centre, Postbox 827, 1180 Av Amstelveen, The Netherlands.

We're going places

For immediate action, dial our toll free automatic answering service 1-800-547-1512

scope meets

	Product	Bw	Dual Trace	Delayed Sweep	Fastest Sweep Rate	Other Special Features
Storage Models	466	100 MHz @ 5 mV/div	yes	yes	5 ns/div	3000 div/μs stored writing speed
	464	100 MHz @ 5 mV/div	yes	yes	5 ns/div	110 div/μs stored writing speed
	434	25 MHz @ 10 mV/div	yes		20 ns/div	Split-screen storage
	314	10 MHz @ 1 mV/div	yes		100 ns/div	Only 10.5 lbs (4.8 kg)
	214	500 kHz @ 10 mV/div	yes		1 μs/div	Only 3.5 lbs (1.6 kg)
	T912	10 MHz @ 2 mV/div	yes		50 ns/div	Low-cost bistable storage
Nonstorage Models	485	350 MHz @ 5 mV/div	yes	yes	1 ns/div	Widest bw in a portable
	475A	250 MHz @ 5 mV/div	yes	yes	1 ns/div	High-performance 250-MHz portable
	475	200 MHz @ 2 mV/div	yes	yes	1 ns/div	Highest gain-bw in a portable
	465B	100 MHz @ 5 mV/div	yes	yes	2 ns/div	Cost effective for 100-MHz bw
	465M	100 MHz @ 5 mV/div	yes	yes	5 ns/div	Triservice standard 100-MHz scope
	455	50 MHz @ 5 mV/div	yes	yes	5 ns/div	Cost effective for 50-MHz bw
	335	35 MHz @ 10 mV/div	yes	yes	20 ns/div	Only 10.5 lbs (4.8 kg)
	305	5 MHz @ 5 mV/div	yes		0.1 μs/div	Autoranging DMM
	221	5 MHz @ 5 mV/div			100 ns/div	Only 3.5 lbs (1.6 kg)
	213	1 MHz @ 20 mV/div			400 ns/div	DMM/Oscilloscope @ 3.7 lbs (1.7 kg)
	212	500 kHz @ 10 mV/div	yes		1 μs/div	Low cost for dual trace & battery
	T935A	35 MHz @ 2 mV/div	yes	yes	10 ns/div	Variable trigger-holdoff and differential
	T932A	35 MHz @ 2 mV/div	yes		10 ns/div	Delayed sweep and differential
	T922	15 MHz @ 2mV/div	yes		20 ns/div	Low-cost dual-trace scope
	T922R	15 MHz @ 2mV/div	yes		20 ns/div	Rackmount version of T922
	T921	15 MHz @ 2mV/div			20 ns/div	Lowest-cost TEKTRONIX Portable
Time Interval Readout	DM44	Optional, factory-installed, direct numerical readout of time intervals and DMM functions for the 464, 465B, 466, 475, 475A				

For price and availablity outside the United States, please contact the nearest Tektronix Field Office, Distributor or Representative.

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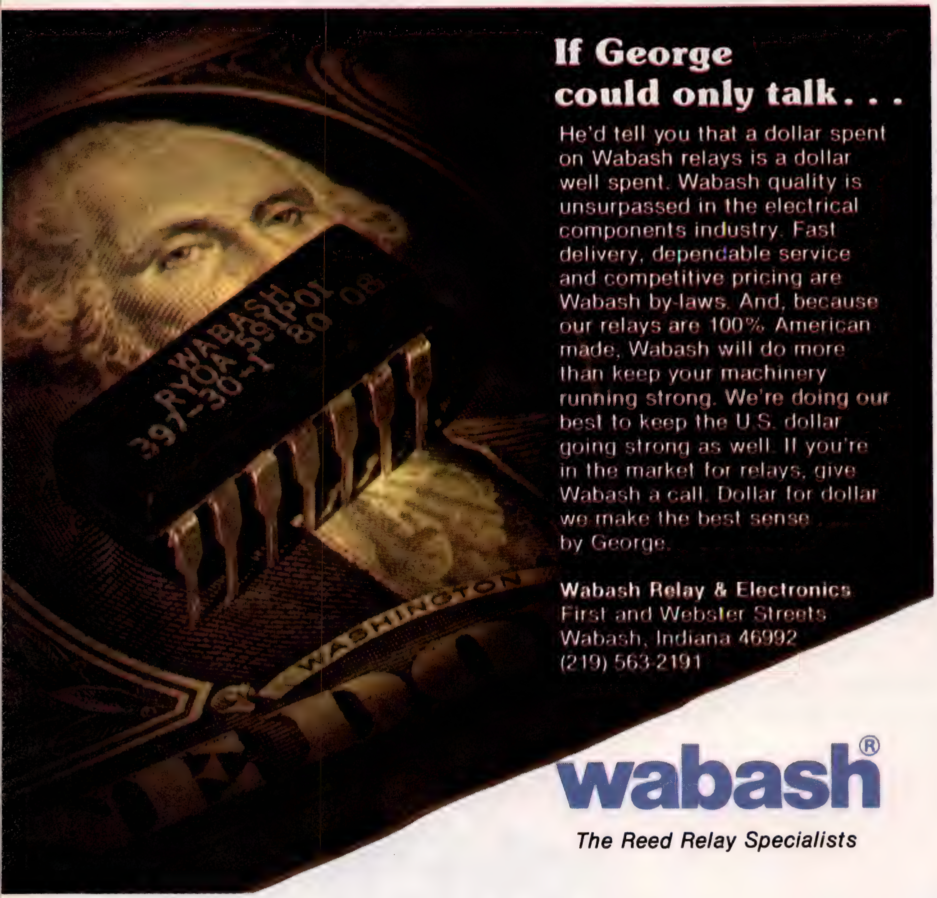

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CIRCLE NO. 79

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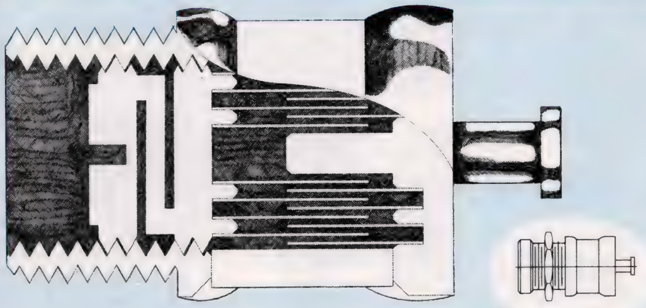

*U.S. patent no. 3,469,160

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Nickel-Plus brand conductors use a combination of silver and nickel to create a solderable, cost efficient system. A controlled, continuous outer layer of pure silver is bonded to an adherent, ductile, inner 50-μin. nickel coating. The combination, used with copper or copper-based alloys, results in a reliable, high-temperature conductor system. Single-end and stranded constructions are offered.

International Wire Products, 500 W. Main St., Wyckoff, NJ 07481. (201) 891-5800.

CIRCLE NO. 344

Flyback cores suit use in switchers

The preadjusted values of type 3C8 pot cores and EC cores have been standardized to facilitate easy application in switched-mode circuits using flyback designs. All core designs are compatible with existing bobbins and hardware.

Ferroxcube, 5083 Kings Hwy., Saugerties, NY 12477. (914) 246-2811. $1.00 to $5.00 (1000 qty).

CIRCLE NO. 345

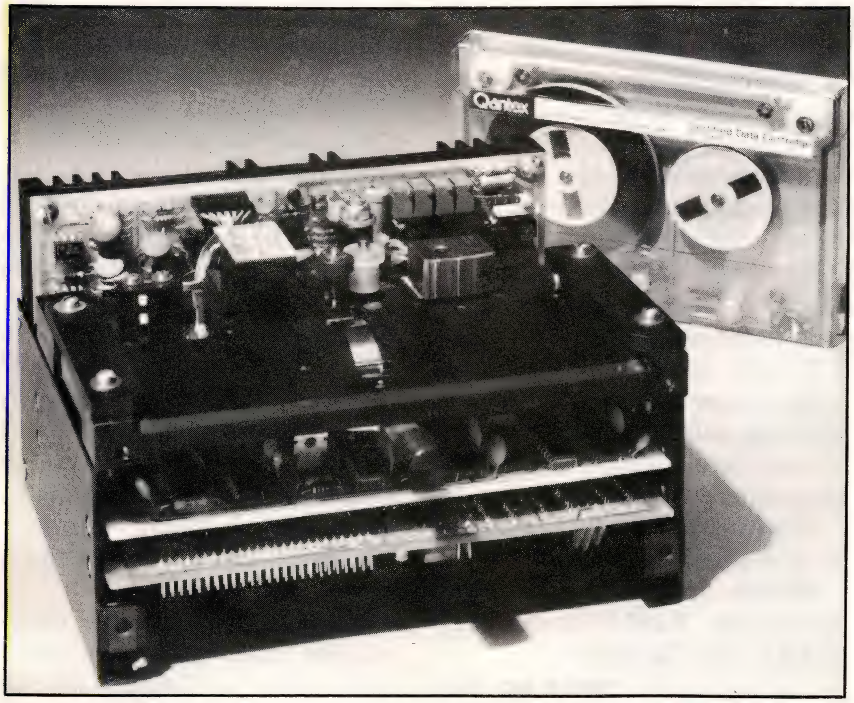
Photoresists yield high-contrast images

A line of positive photoresists produce striation-free coatings for high-contrast images. The material shows good resistance to a variety of etch solutions and offers high-resolution capabilities. Adhesion is good to commonly-used substrates.

Polychrome, P.O. Box 817, Yonkers, NY 10702. (914) 965-8800.

CIRCLE NO. 346

Tape drive quadruples density to 6400 bits/in.



Fewer parts, a digital tachometer, and a hard-mounted drive motor allow the model 400 to store 6400 bits/in. on DC300A tape cartridges.

With newly designed heads and electronics and a new recording code, the model 400 cartridge tape drive quadruples both the recording density and memory capacity of the DC300A cartridge.

Designed mainly for Winchester disk backup and for memory off-loading, the tape transport records four parallel tracks of data on a 1/4-in. magnetic tape at 6400 bits/in. (up from 1600). Memory capacity will be 22 Mbytes (up from 5.4 Mbytes).

The present DC300A cartridge uses a 450-ft. tape that stores 17.2 Mbytes with the help of the 400 drive. A 600-ft. tape will soon be available, raising the storage capacity to 22 Mbytes with the 400 drive.

The drive operates at two speeds. At 30 in./s, the transfer data rate is 192 kbits/s or 24 kbytes/s. In the fast search and rewind modes, the drive operates at 90 in./s, and users can locate any data stored on the 600-ft. tape within approximately 40 s.

With fewer discrete parts than previous models, the drive represents several advances in circuitry, such as a digital (rather than an analog) speed control tachometer. A hard-mounted drive motor, which is coupled to the tape capstan via a spring-loaded idler, decouples the spring-loaded inertia from capstan and tape. A mechanical interlock holds the tape cartridge in place, yet does not interfere with the unit's ejection lever.

In single units, the Model 400 sells for $1585; the OEM price for 100-piece orders is $1075. Delivery for samples is six weeks; for production quantities, 12 weeks.

Qantex Div., North Atlantic Industries, Inc., 60 Plant Av., Hauppauge, NY 11787. Leon Malmed (516) 582-6060. **CIRCLE NO. 310**

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Texas Microsystems Inc.

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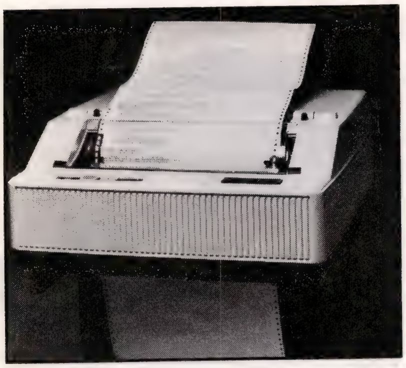
CIRCLE NO. 81

Matrix printer zips along at 900 char/s



The PB600C μP-based matrix printer from Florida Data Corp. uses a magnetic stored-energy print head to operate at 900 characters per second—three times faster than solenoid-based printers. Printing density is 15 char/in. This translates into 600 lines per minute.

In addition, the PB600C can operate at 600 char/s with a density of 10 char/in.—400 lines/min.

The matrix printer is self-contained, with printer mechanics, control electronics, buffer, power supply and enclosure all included. An 894-character (16-line) buffer allows the printer's microprocessor to determine whether it would be faster to print the next line backwards or to return the head to the left margin and print it forwards. The print format is an 8 × 7 matrix with upper and true lower-case letters.

What's more, the user can choose six or eight-line/in. operation—via a front-panel switch or via software selection—by reprogramming internal ROMs.

The PB600C sells for $3100 and is available 30 days ARO.

Florida Data Corp., 3308 New Haven Ave., West Melbourne, FL 32901. (305) 724-6080.

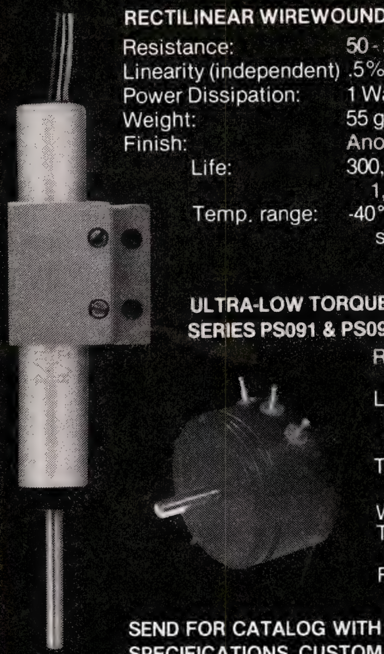
CIRCLE NO. 306

Removable disk cart fits popular drives

A removable disk cartridge, the Nashua 4420, fits Control Data's cartridge module drive, 9448 series and equivalent disk drives. The drive is found in equipment from Honeywell, NCR, Prime Computer, Wang and Ampex. A front insertable, top-loading cartridge, the 4420 stores up to 16 Mbytes. The cartridge has a 0.075-in. disk with one surface used to record data and one surface functioning as a dedicated servo. Density is 348 tracks/in. and 6038 bits/in. at the inside diameter. There are 823 tracks/surface, 807 primary and 15 alternates. A unique handle design saves wear and tear on an operator's fingers. The cartridge is available with factory formatting.

Nashua, 44 Franklin St., Nashua, NH 03061. (603) 880-2323.

CIRCLE NO. 405



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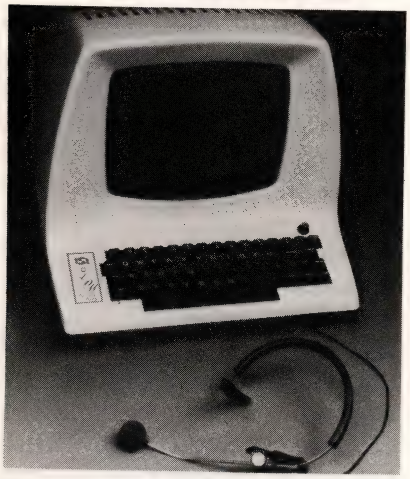
CIRCLE NO. 83

Speech board gives ears to dumb terminals



Vocon 5000, a voice-controlled system, transforms a Lear Siegler ADM-3A Dumb Terminal into a voice-actuated video display terminal. Vocon consists of a user-installable PC board and a high-quality, noise-cancelling microphone. The system recognizes 64 speaker-trained, isolated words or phrases. Several of these word/phrase groups can be stored in the computer's memory to be called up as required. Standard recognition rate is 99%, increasing to 100% when word/voice verification loops are used. The PC board fits easily inside the terminal's housing.

Heuristics, 1285 Hammerwood Ave., Sunnyvale, CA 94086. (408) 734-8532. $2000.

NCC: 1255 CIRCLE NO. 349

Tape cart controller emulates 1/2-in. system

A data cartridge tape controller, TC-180, operates with DEC's PDP-11 computers, emulating the TM-11/TU-10 1/2-in. tape system. The controller extends to PDP-11 users the handling convenience and compact size of the 3M-type data cartridges. Since the DAM controller is transparent to the DEC operating system, the need for write drivers or special software is eliminated. A 6400 bits/in. MFM formatting offers unformatted capacities of up to 17 Mbits per cartridge, making the controller part of a backup system for 8-in. Winchester disk drives. The board interfaces with cartridge drives from DEI, Kennedy, Qantex, DRI and Tandberg at densities of 1600 to 6400 bits/in. Any two adjacent SPC slots can be used to mount the controller with connection to drives made via ribbon cables.

Western Peripherals, 14321 Myford Rd., Tustin, CA 92680. (714) 730-6250. 4 wks.

NCC: 3207 CIRCLE NO. 354

Smart terminal tackles sophisticated data jobs

An intelligent CRT display terminal, ZMS-40, enhances new systems or becomes a versatile addition to a new system design. The unit is housed in a desktop enclosure and includes an 8085A microprocessor with up to 16 kbytes of RAM, a 12-in. diagonal non-glare video display, a keyboard, an asynchronous communications port and an optional RS-232C printer interface. The video display offers 24 lines of 80 characters each. A 25th line gives operator error/status information. The display is refreshed out of main memory, providing the terminal with extended function programming capability. Video enhancements include dim, blank, reverse video, underscore and normal.

Zenteck, 2400 Walsh Ave., Santa Clara, Ca 95050. (408) 727-7662.

CIRCLE NO. 355

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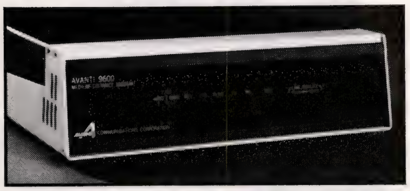
Medium-haul modem transmits 9600 bits/s



Voice-grade telephone lines can now transmit synchronous data at far less cost, for rates up to 9600 bits/s and for circuits less than 100 miles long, using Avanti's Model 9600 modem. Half the price of long-haul modems, the 9600 is the first medium-distance (10 to 100-mile) data set capable of handling 9600 bits/s.

The new modem owes its low price to its limited equalization capability. Its automatic equalizer can compensate for as much as 1700 μs of relative delay distortion between 500 and 2900 Hz and for up to 12 dB of amplitude distortion. Long-haul sets can handle much more distortion, but that expensive capability is not usually needed by medium-distance links. If the modem is not equal to handling the line distortion, the set offers fall-back transmission rates of 7200 and 4800 bits/s, programmable from the terminal equipment by interconnecting the appropriate pins of the set's RS-232C interface.

The new set offers a fast-train mode in which it equalizes a line in less than 100 ms. In all transmission modes, the carrier can be either constant or switched. The modes are half-duplex over two wires, half-duplex over four wires and full-duplex over four wires.

The microprocessor that controls the 9600's equalizer also controls its multilevel and multiphase modulation scheme in a manner compatible with other V.29-type modems. The training sequence, data scrambling and 253-ms RTS/CTS delay are also V.29-compatible.

Comprehensive diagnostics support the set, including such maintenance aids as: data and clock loopback for checking the local digital interface; local loopback for a complete self-check of the modem functions; remote loopback for checking the entire datalink; a MARK clamp switch and remote indicator for checking transmission errors; and an eye-pattern generator which can indicate line quality.

The Model 9600 sells for $3250 in unit quantity; delivery is from stock.

Avanti Communications, Newport, RI 02840 (401) 849-4660.

CIRCLE NO. 301

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- Complement command
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- $1595 with personality modules $90

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1120 San Antonio Road, Palo Alto, CA. 94303
(415) 964-2862

CIRCLE NO. 84

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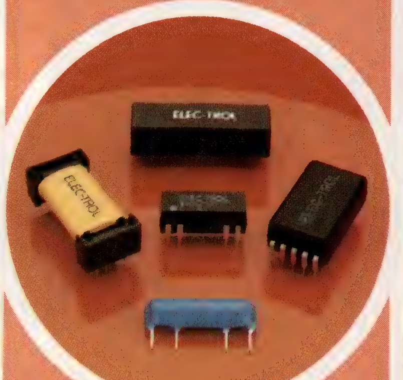
ELEC-TROL

CIRCLE NO. 165

ELEC-TROL REED RELAYS



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CIRCLE NO. 166

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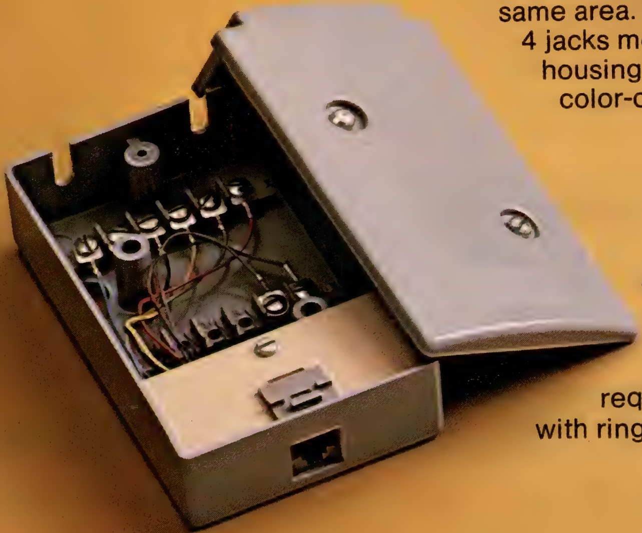
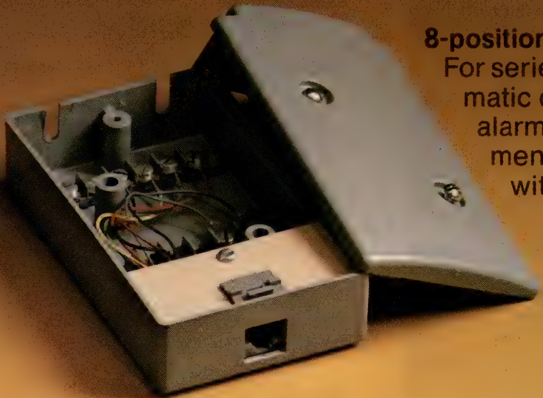
For complete information on the 285 Series, as well as technical data, dimensions, and prices, contact your nearest Amphenol North America sales office or telephone products distributor.

Programmable 8-position keyed data jack.
Consists of 8-position miniature jack specially keyed for data equipment plus a kit of resistors. Resistors provide a loop loss range of 0 to 9 dB in 1 dB steps.

Multiple bridging adapter and jack assembly.
Used when several telephone or ancillary devices are connected to one or two lines in same area. Two sets of 4 jacks mounted in housing. Each jack set color-coded.



8-position jack assembly.
For electronic key systems and ancillary equipment where 4 cable pairs are required. Jack leads equipped with ring lugs.



8-position series jack assembly. For series connection of automatic dialing devices, burglar alarms, certain data equipment. Jack leads equipped with ring lugs.

Universal 8-position keyed data jack. Contains a pad for fixed loop loss operation and a programming resistor for programmable operation. Switch for mode selection. Available in 9 values for a specific loop loss of 0 to 9 dB in 1 dB steps.

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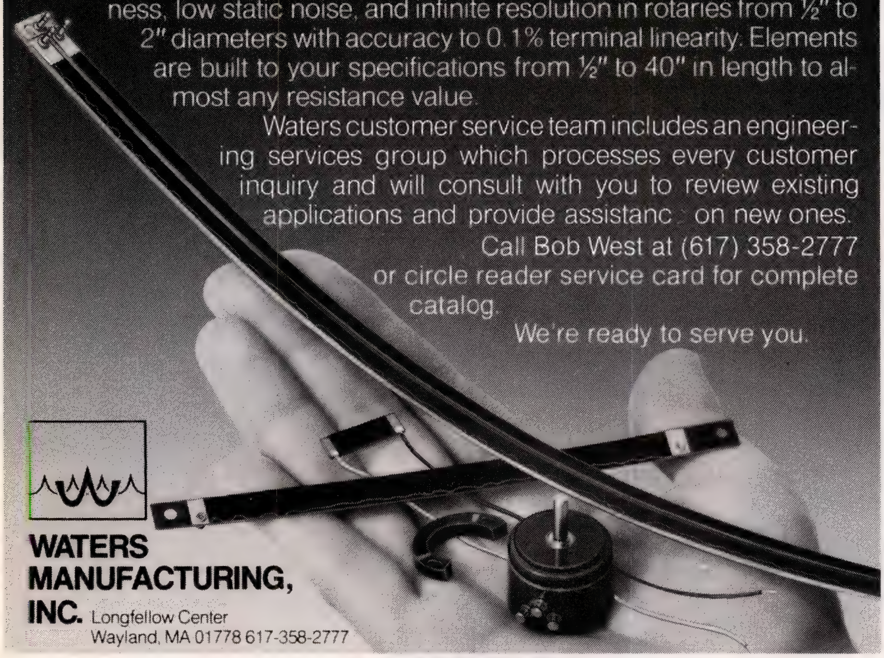

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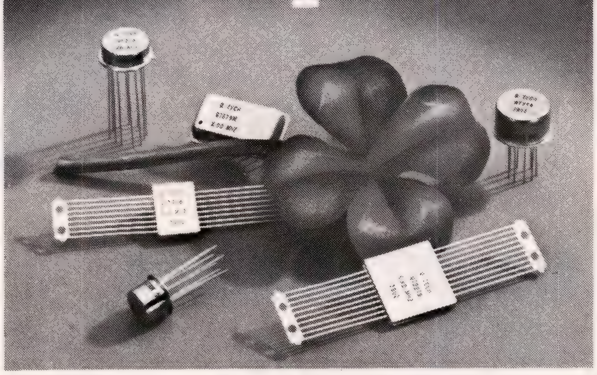


Crystal Clock Oscillators
QPL for MIL-0-55310/08 thru 15

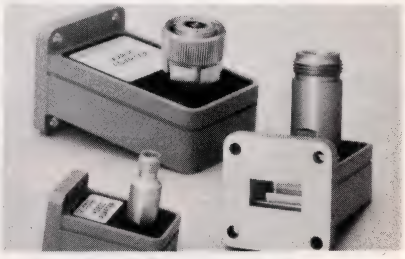
Looking for crystal clock oscillators for high technology projects? And quality that meets the exacting standards of QPL for MIL-0-55310/08 thru 15? LUCKY YOU! Q-Tech has it all — QPL status; TTL; Schottky; MOS; Multiple Outputs to custom logic requirements; Frequency from 0.1Hz on up, with high stability; Precision Time Generators — and a whole lot more. Tell us what you want! For example: Q-Tech produces an oscillator with *both CMOS and TTL drive capabilities.* Send for our 6 page brochure for complete details.

Q-Tech Corporation

2201 Carmelina Avenue • Los Angeles, California 90064
(213) 820-4921 • TELEX 69-6140

CIRCLE NO. 87

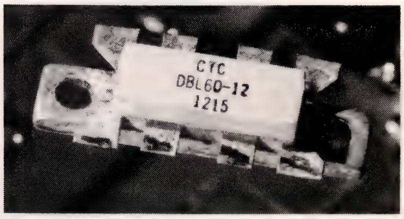
Waveguide/coax adapters reduce errors



A stepped-taper design, used for low SWR, reduces measurement error in HP 281C series waveguide/coaxial adapters. The low SWR lets a user adapt coaxial components, such as power sensors or noise sources, to waveguides with little change in performance. Three models are offered for a 8.2 to 26-GHz range.

Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. (415) 857-1501. $250 to $280; 12 wks. **CIRCLE NO. 356**

Balanced transistors simplify 800-MHz amps



Three high-power balanced transistors offer performance superior to single-ended devices in 800-MHz rf amplifiers. DBL45-12 generates a 45-W output for 15 W drive; DBL60-12, 60 W for 20 W drive; DBL80-12, 80 W for 27 W input. The balanced devices have inherently higher input and output impedances, allowing use of less external components and less complex circuit designs. The transistors are intended for operation in the 806 to 866-MHz communications band.

Communications Transistor, 301 Industrial Way, San Carlos, CA 94070. (415) 592-9390.

CIRCLE NO. 357

The logic of logic analysis

DOLCH introduces the world's first 48-channel logic analyzer

Trace it all, and fast . . .

If you're switching from 8 to 16 bit microprocessors, make sure your logic analyzer can support the move. An adequate number of input channels is the prime prerequisite for 16-bit-uP testing.

Dolch's LAM 4850 is not only the record holder with 48 input channels, it offers you even more of the world's first features such as 3 level simultaneous clocking to untangle multiplexed bus signals or "trigger tracing" that lets you examine nested program execution in real time.

It's features include:

- 1024 bits recording and reference memory per channel
- sampling rates DC to 50 MHz
- 5 ns glitch capability
- 4 level sequential triggering
- binary, hex, octal, ASCII and mnemonics display
- 16-channel x 2048 timing display
- IEEE interface (optional)

DOLCH
LOGIC INSTRUMENTS GMBH
Ottostr. 25, D-6056 Heusenstamm,
Tel. (06104)-6477 · Tlx. 4185102 dli

INTERNATIONAL REPRESENTATIVES

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Kontron Elektronik GmbH
Tel. 089/319 01-1

GREAT BRITAIN
Wavetek Electronics Ltd.
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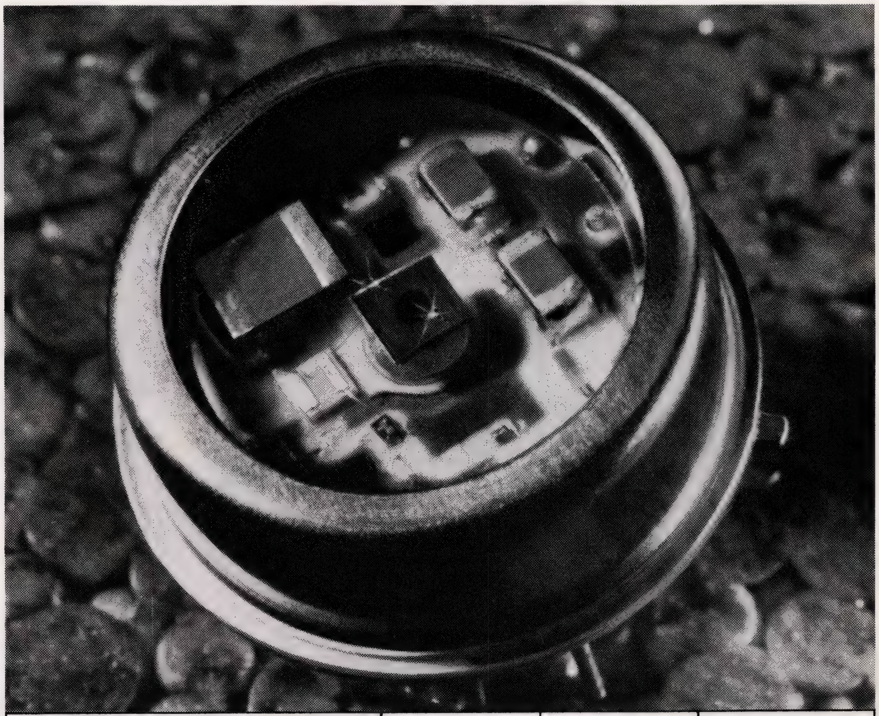
CIRCLE NO. 154 FOR LITERATURE

CIRCLE NO. 155 FOR DEMONSTRATION

RCA

A report on electro optics: Improved avalanche detector/ preamplifier modules.



	C30950E	C30950F	C30950G
Responsivity (at 830nm)	5.2×10^5 V/W	1.9×10^5 V/W	5.8×10^4 V/W
Noise equivalent power (at 830nm)	0.029 pW/Hz$^{1/2}$	0.079 pW/Hz$^{1/2}$	0.260 pW/Hz$^{1/2}$
System bandwidth	50MHz	100 MHz	200MHz

RCA hybrid modules achieve new levels of performance out to 200 MHz (typical).

Our new C30950 line of detector/ preamplifiers offers optimum performance, while maintaining the widest possible bandwidth and highest sensitivity of these devices.

Wide bandwidths.

The C30950 is available in three types. All offer extremely low noise, high responsivity and wide bandwidths (see chart).

Our C30950E is designed to give optimum performance over a bandwidth of 50 MHz. The C30950F extends to 100 MHz.

At the top of the line is the C30950G which delivers its optimum performance as far out as 200 MHz.

Maximum sensitivity.

All three units use our widely acclaimed reach-through avalanche chip combined with a hybrid preamplifier, in a modified TO-8 package.

The built-in preamp section is designed to neutralize the input capacitance of a unity voltage gain preamplifier.

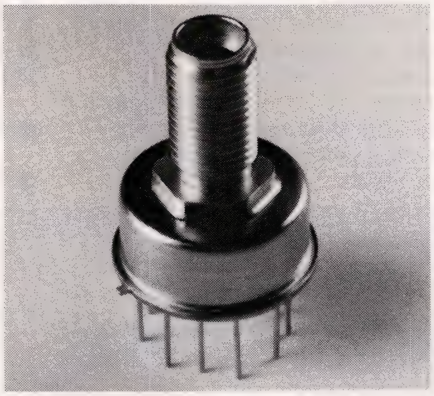
This feature assures maximum sensitivity and minimum noise across the entire bandwidth.

With light-pipes for optical communications.

If your applications demand maximum light transmission, you should consider our C30950 series with built-in light-pipes, for ease of coupling to fiber.

These packages consist of a short piece of fiber or light-pipe precisely centered in a modified TO-8 header.

The light-pipe is brought close to the chip surface to insure correct alignment and minimum light loss.



This optional light-pipe feature makes the C30950 series ideal for optical communications, as well as for military and industrial rangefinding.

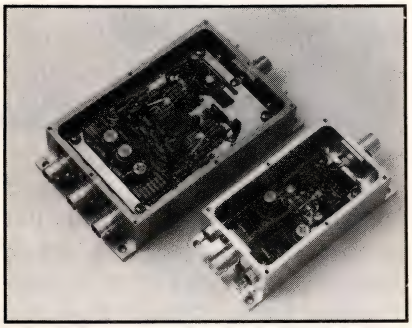
Free technical data.

For complete data on RCA detector/preamplifier modules, contact RCA Ltd., Ste. Anne-de-Bellevue, Quebec, Canada. Telephone (514) 457-9000.

Or RCA Buenos Aires, Argentina. Brussels, Belgium. Sao Paulo, Brazil. Sunbury-on-Thames, Middlesex, England. Paris, France. Stuttgart, West Germany. Mexico 16 D.F., Mexico.

CIRCLE NO. 89

Broadband amplifiers reach down to dc



Two dc-coupled broadband linear amplifiers can take on a variety of applications, ranging from fiber-optic communications to the automatic testing of high-frequency circuit boards. The faster of the two amplifiers, the Model CLC100, has a 3-dB bandwidth of 600 MHz and can deliver +12 dBm of output power at its 1-dB compression point. Extremely flat gain characterizes the unit: It has a frequency response of ±0.15 dB from dc to 300 MHz. The gain is 19.6 ±0.3 dB at 100 MHz.

In addition to its wide bandwidth and fast pulse response (maximum rise and fall times of 750 ps), the CLC100 offers low distortion. Its typical third-order intermodulation intercept point is 33 dBm at 30 MHz and 24 dBm at 400 MHz.

Although slower than the CLC100, the Model CLC101 provides more power, differential inputs, an adjustable output dc offset and adjustable limiting. It has a 3-dB bandwidth of 150 MHz when delivering 18 dBm (63 mW) or 100 MHz when putting out 24 dBm (250 mW).

Both amplifiers require dual $\pm V_{CC}$ power supplies from 5 to 15 V dc. No-load current drain from each supply is a maximum of 45 mA for the CLC100 and 190 mA for the CLC101. The CLC100 sells for about $190; the CLC101 costs approximately $390. Delivery is from stock to 12 weeks.

Comlinear Corp., 514 Railroad Ave., Loveland, CO 80537. David A. Nelson (303) 669-9433.

CIRCLE NO. 302

Thermal tester checks high-current diodes

Theta 150, a thermal resistance tester, provides current pulses up to 100 A to check the steady-state and transient thermal characteristics of high-current diodes, SCRs and triacs. The instrument applies a heating current pulse that heats the diode under test. Sensing the change in junction voltage, under measurement current conditions, before and after the current pulse, the Theta 150 automatically computes thermal resistance for front-panel display up to 19.99 C/W.

Sage Enterprises, 1080 Linda Vista Ave., Mountain View, CA 94043. (415) 969-5111. $25,000 to $40,000; 17 to 26 wks.

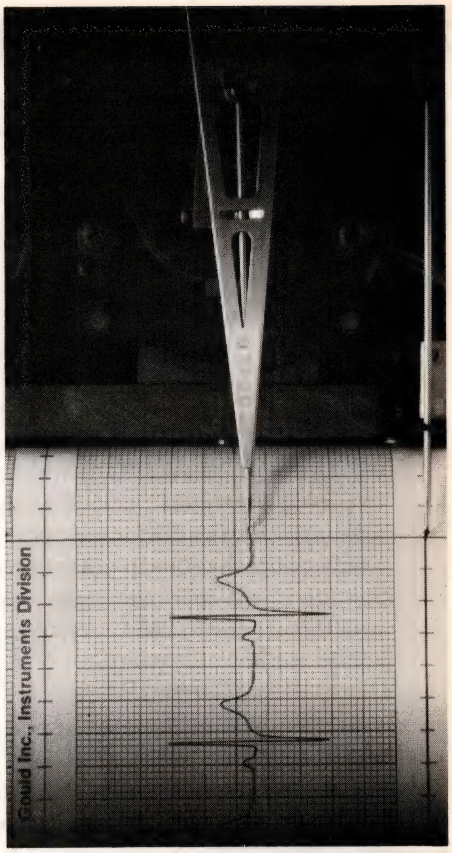
CIRCLE NO. 394

Talking voltmeter aids visually impaired

A benchtop voltmeter, equipped with a speech synthesizer, assists electronics and electrical work by the visually handicapped. The dual-μP-based system provides voltage readings that are automatically announced every 7 s or on command from an operator. A slave processor selects speech elements from a ROM while a main processor controls system timing and signal processing. The portable instrument is powered by a rechargeable NiCd battery pack.

Franklin Institute Research Laboratory, Benjamin Franklin Pkwy., Philadelphia, PA 19103. (215) 448-1340.

CIRCLE NO. 395



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GOULD

An Electrical/Electronics Company

CIRCLE NO. 90

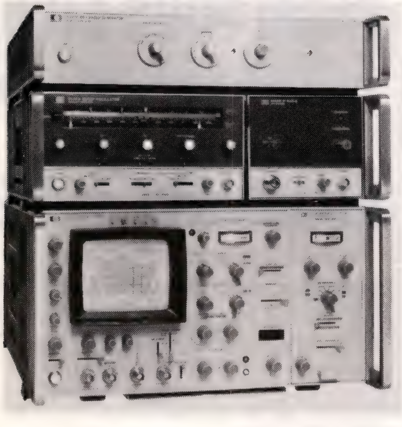
Switchable thermometer eliminates conversion

Model 1112, an LCD display, digital thermometer, switches between Fahrenheit and Celsius reading with the flick of a switch. Conversion charts are not needed to take quick readings from −60 to 410 F or −50 to 215 C. Accuracy is 0.5° while resolution is 1 F (0.1 C). A wide selection of probes is available including air, surface and immersion types.

Extech International, 114 State St., Boston, MA 02109. (617) 227-7090. $135.

CIRCLE NO. 358

Sweep generator cuts cost of datacomm tests

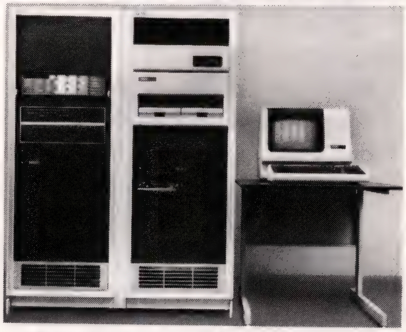


A sweep generator, the HP 3707A BB +, works with existing microwave link analyzer equipment to reduce the cost of a test system. The instrument drives an HP 8620C up-converter to give a swept, FM source from 0.5 to 18 GHz. Used with an HP 3702B or 3712A i-f/baseband receiver, the source helps measure transmission distortion in a radio link. Although its principal area of application is in digital radio testing the unit works well in testing of analog radio systems using direct modulation. The HP 3707A provides a single, low-frequency tone of 250 or 500 kHz (internally selectable) which allows measurement of linearity and group delay.

Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. (415) 857-1501. $1950; 8 wks.

CIRCLE NO. 359

Parametric tester monitors wafer process



A programmable, minicomputer-controlled, wafer-level parametric test system, System 2A, evaluates and characterizes wafer test patterns for use in process control, characterization and quality control in IC manufacturing. The system can be configured for other purposes, such as testing of discrete semiconductor devices or functional circuits. System 2A performs a wide range of tests requiring program-controlled electrical stimuli (dc and pulsed current and voltage), measurement of current, voltage, capacitance and resistance and control of external devices, such as probers. Standard modules are provided for forcing dc current (from 100 pA to 100 mA at up to 125 V) and dc voltage (from 1 mV to 300 V at up to 1 A). A DEC PDP 11/03 is standard with a PDP 11/23 offered as an option.

Keithley, 28775 Aurora Rd., Cleveland, OH 44139. (216) 248-0400. From $45,000; 17 wks.

CIRCLE NO. 360

Low-cost DPM replaces mechanical meters

A low-profile digital panel meter, DM-3100N, performs like a laboratory instrument yet is inexpensive enough to replace mechanical meters. The 3½ digit unit offers 0.1% accuracy and 1000-MΩ balanced differential inputs. Voltage is displayed from −1.999 to +1.999 V dc on 0.5-in. high red LED numerals. Blank circuit pads accept voltage attenuation resistors, current shunts or digital ohmmeter components. Features include an autozeroed input amplifier, ratiometric measurement capability and a common-mode rejection of 80 dB. The unit's polycarbonate case measures 2.53 × 3.25 × 0.94 in.

Datel-Intersil, 11 Cabot Blvd., Mansfield, MA 02048. (617) 339-9341. $34 (100 qty); 2 to 4 wks.

CIRCLE NO. 361

Digital multimeter gives transistor test bonus

A built-in test socket on the WD-747 digital multimeter allows testing of transistor forward current (h_{fe}). The 3½ digit LCD meter measures dc and ac voltage, dc current (up to 10 A) and resistance. Features include resolution to 100 μV, an accuracy of better than 0.8%, dc input impedance of 10 MΩ, autopolarity, autodecimal and full overload protection. Side button function keys are color-coded to reduce operator error. The unit comes with a 9-V battery, test probes and a spare fuse.

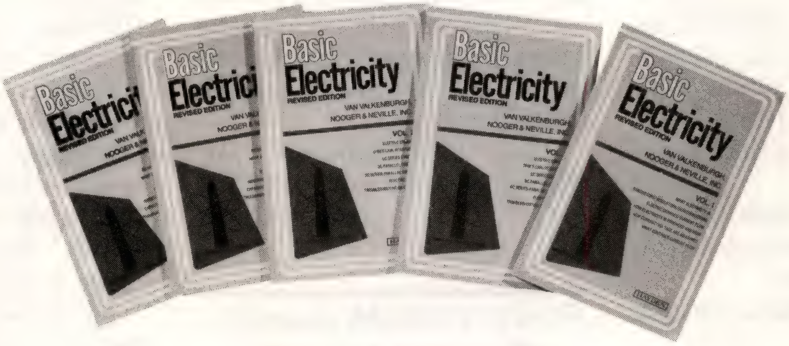
VIZ Manufacturing, 335 E. Price St., Philadelphia, PA 19144. (215) 844-2626. $89.95.

CIRCLE NO. 362

The #1 training course in electricity . . . is now even better!

BASIC ELECTRICITY Revised Edition

by **Van Valkenburgh, Nooger & Neville, Inc.**



Based on the famous COMMON-CORE® course in electricity used to train over 100,000 naval technicians in record time! This thoroughly revised 5-volume series offers comprehensive coverage of how electricity is produced, why it behaves in certain ways in circuits, and how it is measured, controlled, and used. Available in one clothbound edition, a 5-volume paperbound set, or in individual volumes. Examinations are also available.

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by **Van Valkenburgh, Nooger & Neville, Inc.**

Here is a completely revised edition of the widely-acclaimed course on basic electronics for beginners. This 5-volume course covers in detail, with illustrations, all the information on the latest applications of basic solid-state electronics. This step-by-step course is the perfect follow-up to **BASIC ELECTRICITY.**

For more information, write to:

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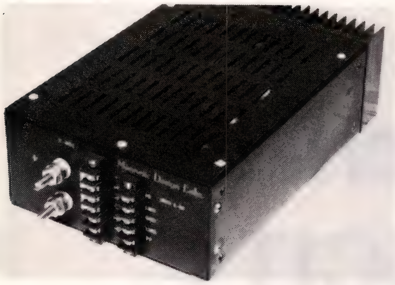
5-V switcher packs 1.3 W/in.^{3}



A 5-V, 50-A switching regulated power supply, Model 5-50, packs a power density of 1.3 W/in.^{3}. The supply features regulation of 0.03%, an efficiency of 70% minimum, noise and ripple of 30 mV pk-pk and a holdup time of 30 ms minimum. Input range is 92 to 130 V; operating range, 0 to 70 C. The supply offers overvoltage protection, current-limiting, soft-start and remote shutdown.

Magnetic Design Labs, 1636-H E. Edinger Ave., Santa Ana, CA 92705. (714) 558-3355.

CIRCLE NO. 363

4-digit LED display carries on-chip driver

A four-digit LED display, NSM4000A, carries its own serial data in/parallel data out LED driver. The assembly is designed to operate with minimal interface to a data source. Constructed on a standard PC-board substrate and covered with a plastic lens, the display contains outputs for two additional LEDs. The digits measure 0.3-in. high. LED current is fully programmable. Direct current drive is used. The TTL-compatible unit operates from a wide range of power supplies. Applications include digital clocks, thermometers, counters and voltmeters.

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. (408) 737-5000. $11.24; stock. **CIRCLE NO. 364**

LED assembly makes ready-to-go DPM

A naked digital panel meter, complete with a/d converter and decoder/driver, makes an ideal build-in board for instrumentation, monitoring equipment and test equipment. DM-10815 features a range of −99 to +999 mV with a typical accuracy of ±0.1%. Integrated on the same PC board are gain and zero adjust control and a three-digit, 0.6-in. high orange LED display. The board measures 2.3 × 1.75 in. For overrange indication, the display will read "EEE." When a reading exceeds −99 mV, the display shows "---." The DPM board operates from a 5-V dc supply and requires only 10 mA forward current per segment at 25 C.

Opcoa, 330 Talmadge Rd., Edison, NJ 08817. (201) 287-0355.

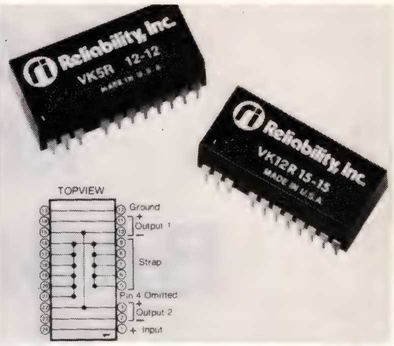
CIRCLE NO. 365

Power module accepts PC-mount supplies

A bench adapter, BenchMate, supplies power input and output power connections for PC-mount encapsulated power supplies. The adapter facilitates breadboard, testing and general laboratory use of the modular supplies. BenchMate consists of a 3.5 × 2.5 × 1.25-in. plastic case with five manifold ports which accept the input/output pins on the firm's ac/dc single and dual-output power supplies. The power supplies' dc voltage output can be tapped through BenchMate's three terminal binding posts using banana jacks, alligator clips or plain wire leads. A user simply inserts the required supply into the corresponding ports and flips a switch.

Power Products, 1400 N.W. 70th St., Fort Lauderdale, FL 33309. (305) 974-5500. $34.50 (3 days). **CIRCLE NO. 366**

Dc/dc converters power analog/logic circuits



VK Series dc/dc converters supply low-noise, regulated power for operational amplifiers, comparators, d/a and a/d converters, CPUs and PROMs. The DIP-size units accept a 5 or 12-V dc input and provide regulated outputs at ±12 or ±15 V dc at 1 W. Output tolerance is ±5%; output ripple, 30 mV pk-pk maximum. Line and load regulation is 0.3% while isolation is 10 MΩ at 50 V. Operating temperature range extends from 0 to 70 C.

Burr-Brown, International Airport, Industrial Park, Tucson AZ 85734. (602) 746-1111.

CIRCLE NO. 367

Triple/quad supplies power μP circuits

A series of triple and quad output power modules supplies the needs of microprocessor-based circuits. All versions operate from a 115-V ac input with a 230-V ac option available. The 5-V dc output supplies from ±500 to ±2000 mA. Quad output models have a −5 V dc output at −100 mA. Current capability for the ±12 and ±15 V dc outputs ranges from ±100 to ±300 mA. Line and load regulation is 0.1% for 5 V and 0.05% for the ±12 and ±15 V outputs. Ripple and noise are held to 1 mV rms.

AAK, P.O. Box 7, Methuen, MA 01844. (617) 373-3769. From $75.

CIRCLE NO. 368

Think Twice

Intel's new 8272 controller for double density floppy disks lets you command shorter design times.

Why have second thoughts about designing a double density floppy disk drive into your system, when Intel's 8272 is available now. With a powerful command set, microprocessor compatibility, Intel's HMOS* technology and the ability to reduce CPU overhead, our controller for IBM compatible single or double density floppy disks is the logical choice for system designers.

Now, you don't have to spend months building and programming an entire board of interface logic to control one, two, three or four double density floppy disk drives. Just incorporate Intel's new 8272 controller into your design to save time and space. Our double density floppy disk controller does more than reduce your parts count 50 to 1. It gives you enough flexibility to shorten your design cycle. And Intel's 8272 offers you the freedom of designing in the 5-volt world.

Freedom for the CPU.

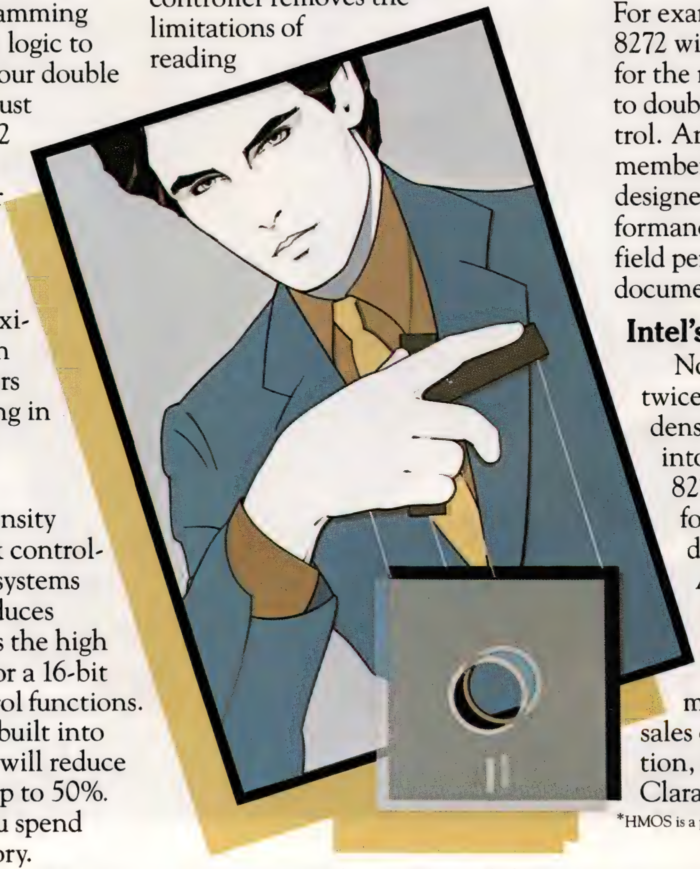
Our new 8272 double density floppy and mini-floppy disk controller is the right solution for systems designers. It saves time, reduces power dissipation and slices the high cost of burdening an 8-bit or a 16-bit CPU with floppy disk control functions. A powerful instruction set built into Intel's new 8272 controller will reduce your programming efforts up to 50%. Less code is required, so you spend less time and use less memory.

Intel's 8272 solution also tackles the problem of CPU overhead and software intervention. Our double density floppy disk controller has the capability of scanning a single sector or an entire track's worth of data fields. Data on the floppy disk gets compared byte-by-byte with data in your system memory. And, since a single command locates and compares the data, no additional software is necessary.

Faster data access.

Our new 8272 controller does more than drive up to four floppy disks simultaneously. It handles parallel seek on up to four disks for faster data access.

With multi-sector and multi-track transfer capabilities, the CPU is freed from time-consuming I/O commands. Our new double density floppy disk controller removes the limitations of reading or writing only the number of characters a physical sector allows. The 8272 automatically transfers data across the disk's consecutive sectors... and, as a result, the CPU isn't forced to wait until the next sector is positioned. With Intel's new 8272, you not only free the CPU, you get the assurance of higher system performance.



Easy microprocessor compatibility.

Intel delivers the new 8272 double density floppy disk controller into the 5-volt world. That makes our controller an easy, compatible interface with Intel's family of microprocessors like our 8086, 8088 and 8085.

As part of the Intel peripheral family, the new 8272 complements our other dedicated LSI performers. For example, you can team our 8272 with an 8237 DMA controller for the most bus-efficient solution to double density floppy disk control. And like our other family members, the 8272 offers systems designers highly reliable performance... plus the support of field personnel and complete documentation.

Intel's new 8272, here today.

Now, you don't have to think twice about designing a double density floppy disk controller into your system. With Intel's 8272, you won't have to settle for fewer features or a long design cycle, either. Why wait. Already second sourced, our 8272 is on your distributor's shelves today.

For more detailed information, contact your local Intel sales office or write: Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA 95051.

*HMOS is a patented Intel process.

intel® delivers solutions.

Europe: Intel International, Brussels, Belgium. Japan: Intel Japan, Tokyo. United States and Canadian distributors: Alliance, Almac/Stroum, Arrow Electronics, Avnet Electronics, Component Specialties, Hamilton/Avnet, Hamilton/Electro Sales, Harvey, Industrial Components, Pioneer, L.A. Varah, Wyle Distribution Group, Zentronics.

CIRCLE NO. 92

designer collection by WESTON

It's the designer collection of finest-quality cermet trimmers from Weston. It's everything you would expect in a designer collection from expert styling and superior craftsmanship to long-term durability and reliable performance **at competitive prices!** Choose from the 830 (¾" rect. multiturn), 840 (⅜" sq. single turn), 850 (⅜" sq. multiturn) or the 860 (¼" sq. multiturn).

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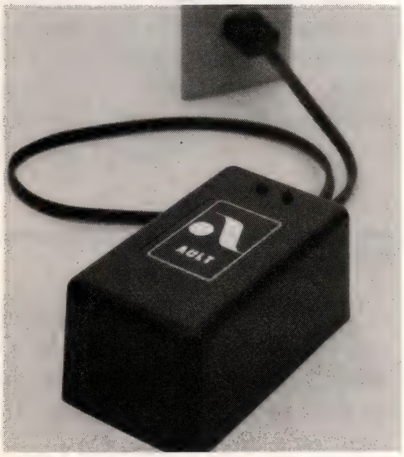
CIRCLE NO. 93

Charger perks up lead-acid/gel batteries

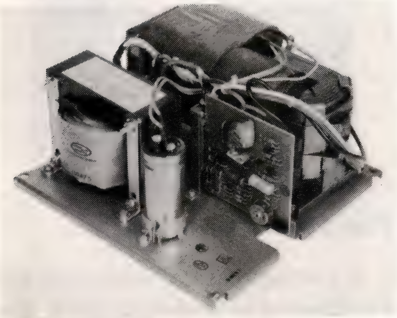


A battery charger restores full charge to lead-acid and gel-type batteries used in instrumentation and communications equipment. The unit's 3-A charging rate is especially suited to 20 and 40-Ah batteries. Internally, a voltage-sensing circuit controls an electromechanical relay. As a 6, 12 or 24-V battery approaches full charge, the relay automatically drops out. A regulating circuit takes over to maintain a float charge. The charger can be connected to a battery without fear of overcharging or other damage to the battery.

Ault, 1600 H. Freeway Blvd., Minneapolis, MN 55430. (612) 560-9300.

CIRCLE NO. 369

Open-frame conditioner overcomes brownouts

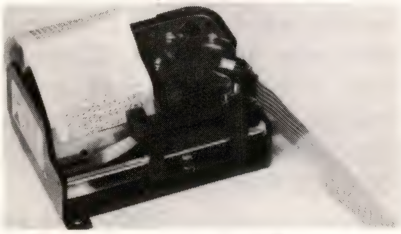


An open-frame ac line conditioner connects inside computers to provide protection against unstable voltage and frequency conditions. Model C474 supplies 2000 VA of regulated and filtered power from a 90 to 130-V ac source. Regulation is ±1% for line changes and ±1.5% for load changes of 25 to 100%. Power efficiency is as high as 90% at full load. Only convection cooling is required at ambient temperatures from 0 to 55 C. Inherent current-limiting is included to afford immunity to overload and short-circuit conditions. Since Model C474 is insensitive to frequency, the unit is suited for field operating conditions where rotary generator power is being used. The unit is UL recognized.

Adtech Power, 1621 S. Sinclair St., Anaheim, CA 92806. (714) 634-9211. $374.20; stock to 4 wks.

CIRCLE NO. 370

Miniprinters weigh only 2.8 oz



Two miniature alphanumeric printers produce 15 characters per line in a 7 × 5 matrix on electrosensitive (Model EUY-2E) or thermally-sensitive (EUY-2T) paper. The microprinters weigh only 2.8 oz and measure 2.83 × 1.32 × 2.2 in. Both use 1.42-in. wide paper and print 0.11-in. high characters. The electrosensitive version operates at up to two lines/s; the thermal unit, 1.5 lines/s. Model EUY-2E requires a 5 and −31 V dc supply, while the thermal unit takes 5 V dc only.

Panasonic, One Panasonic Way, Secaucus, NJ 07094. Richard Present (201) 348-7289. $28 (EUY-2E); $42 (EUY-2T) (OEM qty); 16 wks.

CIRCLE NO. 371

SUPER MINIATURE

Neon Glow Lamps

Circuits Volts··············AC105-125
Series Resistance········ 150KΩ
Nominal Current········· 0.3mA
Total Flux···················20mlm MIN.
Average Life Hours······30,000

φ3.8mm
11mm
NL-8S

CLEAR -GREEN

Fluorescent Glow Lamps

Circuit Volts··············AC crDC105-125
Series Resistance······· 33KΩ
Nominal Current········· 1.6mA
Total Flux(MIN.)········ AC:120mlm, DC:130mlm
Avg. Life Hours ·········AC:30,000, DC:40,000
Circuit Volts··············· AC105-125
Series Resistace·········27KΩ
Nominal Current········· 1.5mA
Total Flux··············· 90mlm MIN.
Avg. Life Hours········· 20,000

φ6.0mm
19mm
NL-35/G
φ6.0mm
22mm
NL-21/G

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NEON GLOW LAMP, XENON FLASH LAMP, RARE GAS, DISCHARGE LAMP.
MINIATURE : BLACK-LIGHT, UV-LIGHT, FLUORESCENT COLOR-LIGHT.

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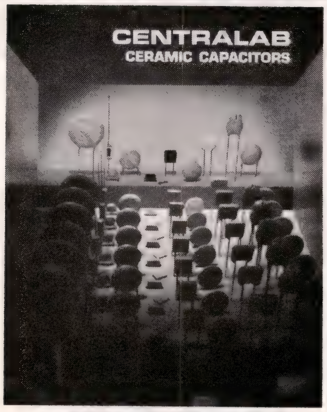
CIRCLE NO. 94

New Literature



Ceramic capacitors

A 44-page capacitor catalog features ceramic monolithic and disk capacitors. A selector chart is included. Centralab, Milwaukee, WI

CIRCLE NO. 372

Connectors

Connectors and feedthroughs with precision pipe fittings are described in a six-page catalog. Graphs are provided to help approximate electrical ratings. Ceramaseal, New Lebanon Center, NY **CIRCLE NO. 373**

Autotransformers

Applications, features and specifications on autotransformers and voltage regulators are covered in a 28-page catalog. Technipower, A Penril Co., Danbury, CT **CIRCLE NO. 374**

Thick-film conductors

Standard thick film conductors, resistors and dielectrics are described in a brochure. Each of these categories is subdivided into materials for use with ceramic, organic and porcelain substrates. Electro Materials Corp. of America, Mamaroneck, NY

CIRCLE NO. 375

Test set

An application note describes and defines the various PCM codes available in the PTS-107 bit-error-rate test set. Other topics discussed are burst-mode operation, use of fixed word patterns in bit-error-rate testing, use of external clock input and use of a zero addition feature. Tautron, Chelmsford, MA **CIRCLE NO. 376**

Power semiconductors

A 40-page catalog features power semiconductors. Electrical, mechanical and thermal specifications are included. A table for calculating rectifier circuits is given. Semikron International, Hudson, NH **CIRCLE NO. 377**

4-A rectifiers

Major voltage and current ratings of 4-A axial lead, fast recovery rectifiers are given in a four-page data sheet. Electrical and thermal-mechanical specifications are included. International Rectifier, Semiconductor Div., El Segundo, CA

CIRCLE NO. 378

Circuit breakers

Capabilities and features of AP/UP electromagnetic circuit breakers are discussed in a 16-page brochure. Delay curves, mounting details, dimensions and rupture capabilities are diagrammed. Airpax, Cambridge, MD **CIRCLE NO. 379**

Control system

The network Supervisory System, a network control and supervisory system, is shown in an eight-page brochure. Digi-Log, Horsham, PA **CIRCLE NO. 380**

Semi test system

The T327 discrete semiconductor test system, with data logging capabilities and menu programming, is described in a six-page brochure. Teradyne, Boston, MA

CIRCLE NO. 381

Array circuits

Ten linear Monochips, including four new arrays—the MOG, MOH, MOJ and MOL, are described in a 28-page catalog. Interdesign, Sunnyvale, CA

CIRCLE NO. 382

Electrical tapes

Electrical tapes made from Mylar polyester film are described in a two-page data sheet. CHR Industries, New Haven, CT

CIRCLE NO. 383

Curable epoxy

A bulletin describes a 5-s UV curable additive plating resist. 3M, St. Paul, MN

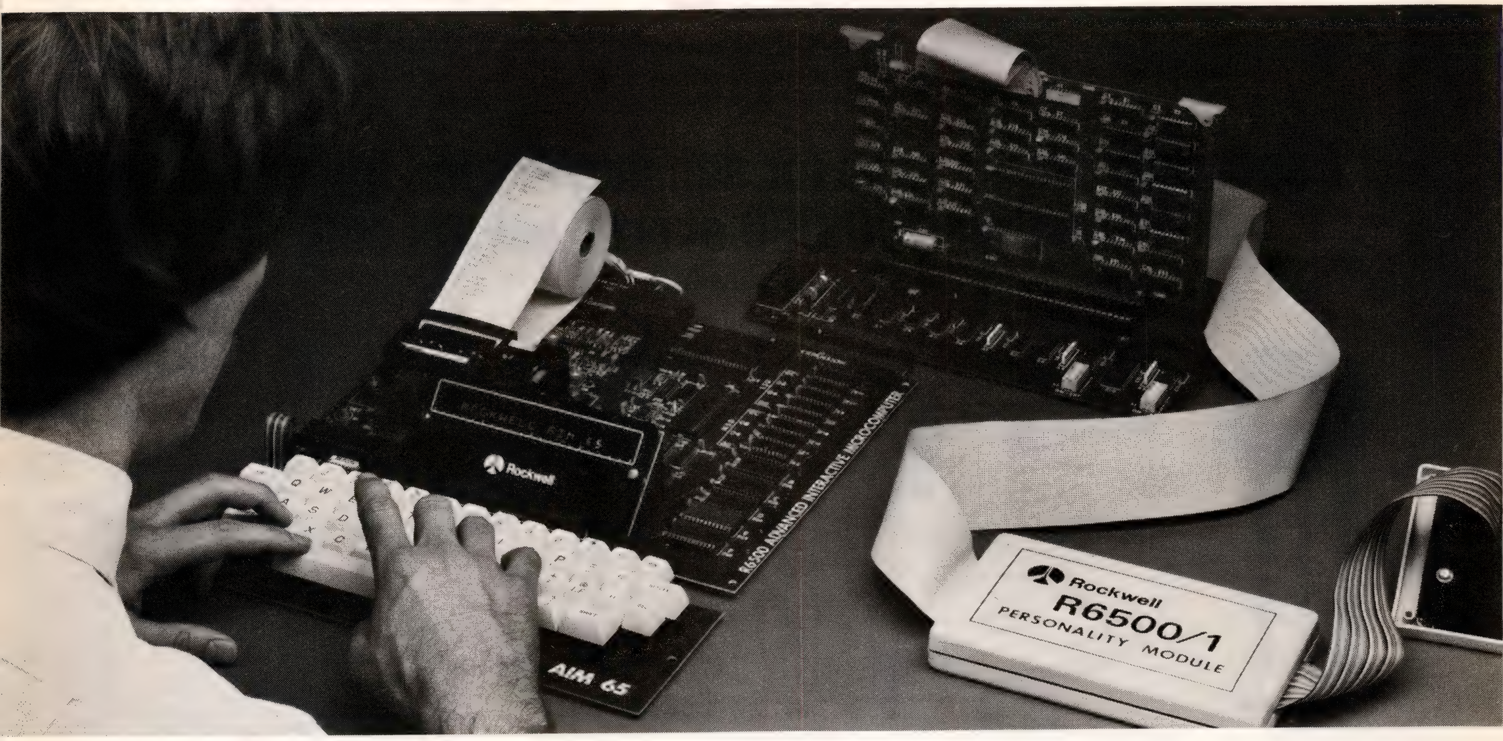
CIRCLE NO. 384

Flat cable/connectors

A 28-page catalog describes flat flexible cable and insulation displacement connectors. Alpha/CW, Elizabeth, NJ

CIRCLE NO. 385

Rockwell announces in-circuit emulation at evaluation board prices.



AIM 65-based Desktop Development Center cuts cost of R6500/1 family software and hardware design.

Micro power

Rockwell International announces a microcomputer development system with in-circuit emulation at the price of most evaluation boards. The heart of this Desktop Development Center is the AIM 65 Advanced Interactive Microcomputer with full alphanumeric keyboard, printer and display.

AIM 65 connects to Rockwell's System 65-bus-compatible Motherboard*, R6500/1 Personality Module and additional RAM card to achieve in-circuit emulation of Rockwell's R6500/1 single-chip microcomputer. The result: economical microprocessor evaluation, development, debugging and more. That's Rockwell Micropower!

AIM 65's resident Text and Symbolic Assembler Editor speed program development. And the Debug provides trace, edit, and breakpoint to troubleshoot software and hardware. An optional high level design language, PL/65, is available.

But the AIM 65 Desktop Development Center is more than just a development tool. Engineers use it as a self-study educational microcomputer, as a professional printing microcomputer using BASIC, and as an OEM standard board computer.

The AIM 65 expands to include additional Rockwell RAM, PROM and ROM cards, and Rockwell Bubble Memory, as well as bus-compatible analog and solid state relay products from Burr-Brown, Compas Microsystems and others.

For more information contact your local distributor or write or call AIM 65 Marketing, Electronic Devices Division, Rockwell International, P.O. BOX 3669, RC55, Anaheim, CA 92803, (714) 632-3729.

**Compatible with EXORciser® and Micromodule bus. EXORcisor® and Micromodule are trademarks of Motorola, Inc.*

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CIRCLE NO. 95

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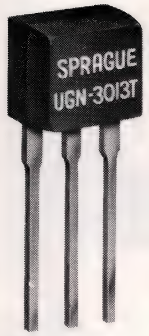

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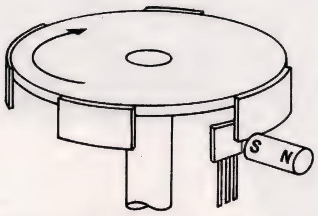
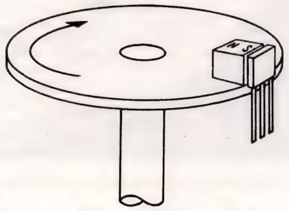
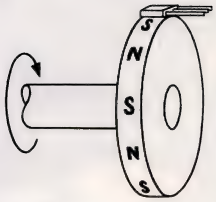


VANE SWITCH

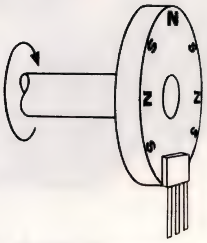


"SLIDE BY" MODE

3x actual size



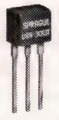
RADIALLY-MAGNETIZED RING MAGNET



AXIALLY-MAGNETIZED RING MAGNET

Type UGN-3013T is a low-cost version of Sprague's well-known UGN-3019T unipolar digital switch. It can be used with inexpensive permanent magnets in a "slide by" mode application or in a vane switch assembly with a rotating vane.

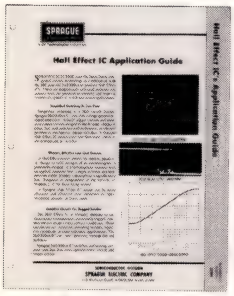
Operate point	450 Gauss (max.)
Release point	25 Gauss (min.)
Power supply	4.5 to 16 VDC
Output voltage	400 mV (max.)
Sink current	20 mA (max.)
Operating temperature range	0°C to 70°C



ACTUAL SIZE

Type UGN-3030T bipolar digital device expressly designed to work with inexpensive, readily-available ring magnets. Up to 20 pulses per inch of diameter per revolution are possible. Nothing rotates too slow or too fast for this IC.

Operate point	250 Gauss (max.)
Release point	− 250 Gauss (min.)
Power supply	4.5 to 16 VDC
Output voltage	400 mV (max.)
Sink current	20 mA (max.)
Operating temperature range	0°C to 70°C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CIRCLE NO. 96

New Literature

Winchester disks

Winchester Disk Back-up, four pages, discusses why back-up is necessary; what media can be used for back-up; streaming or incremental recording and controlling the system. Data Electronics, San Diego, CA

CIRCLE NO. 386

Switches, receptacles

Rotary snap switches, single-pole heavy-duty pushbutton switches, rotary thumb switches and male receptacles are described in a catalog. Tower Manufacturing, Providence, RI

CIRCLE NO. 387

Coaxial connectors

Tools, methods and technical data needed to complete cable assemblies that meet the requirements of MIL-C-39012 are shown in a manual. Microwave Connector Div., Omni Spectra, Waltham, MA **CIRCLE NO. 388**

Fast poll modem

The GDC 4802E(D) V.27 bis and V.27 ter compatible fast poll modem is described in a data sheet. General DataComm, Danbury, CT **CIRCLE NO. 389**

Application Notes

Interference contrast

How the Nomarski differential interference contrast in incident light creates dramatic 3D effects, making the minutest surface irregularities visible, is explained in a 12-page brochure. Carl Zeiss, New York, NY **CIRCLE NO. 390**

Measurement problems

Typical Examples of Measurement Problems and Their Solutions shows answers to 40 typical problems, such as precision measurement of force, weight, pressure, torque, strain, vibration, acceleration and displacement. The solutions are illustrated with drawings and schematics. Hottinger Baldwin Measurements, Framingham, MA **CIRCLE NO. 391**

Surge testing

Diagnostic surge testing, a relatively new capability in the field of high-energy pulse simulation, is described in a 16-page application note. KeyTek Instrument, Burlington, MA **CIRCLE NO. 392**

Tubes, amplifiers

Applications of Vortex tubes and transvector air flow amplifiers are shown in a 24-page notebook. Vortec, Cincinnati, OH

CIRCLE NO. 393

Thermoformed plastic

Fundamentals of Sheet Forming, A Basic Guide and Review contains applications, advantages and limitations of thermoformed plastic sheets. Dow Chemical U.S.A., Midland, MI

CIRCLE NO. 410

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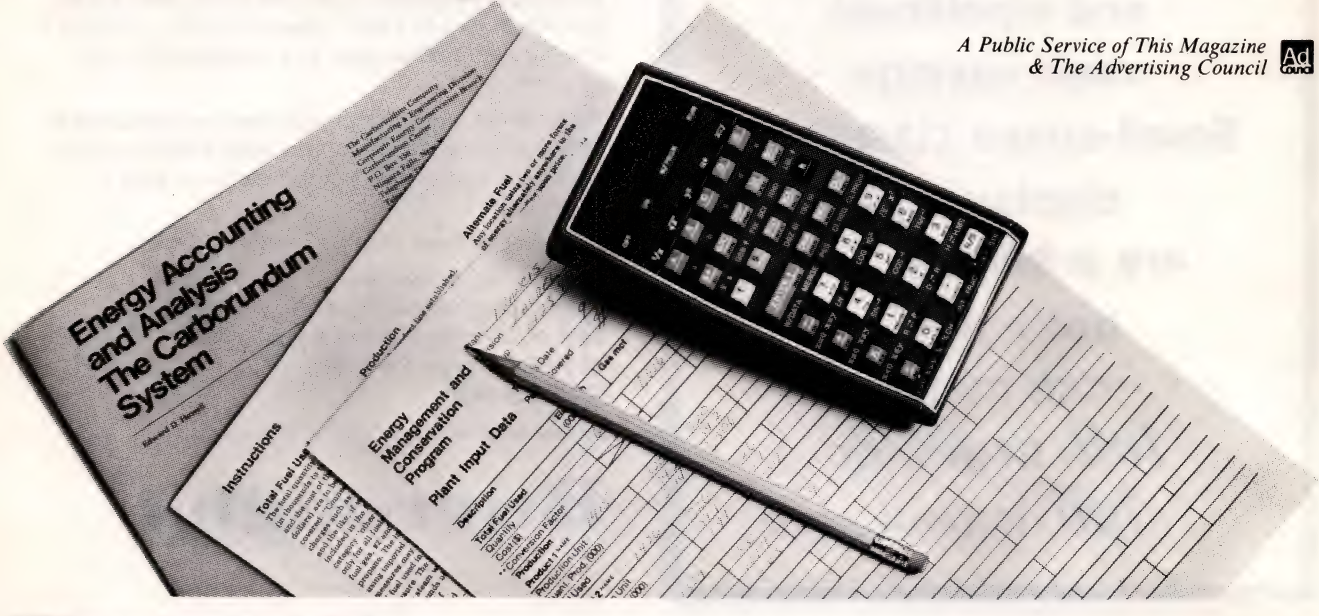
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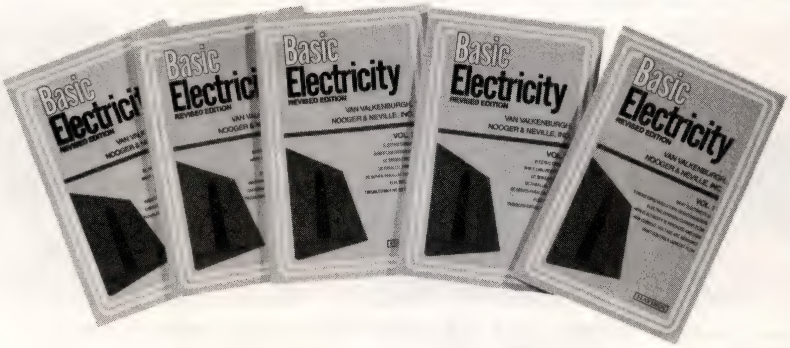

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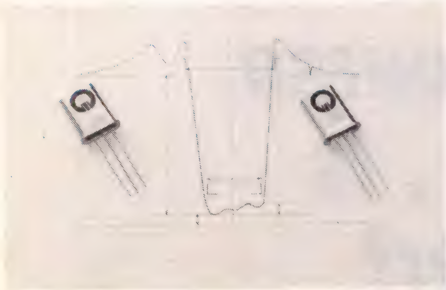

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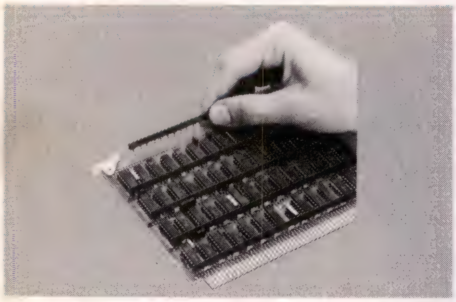

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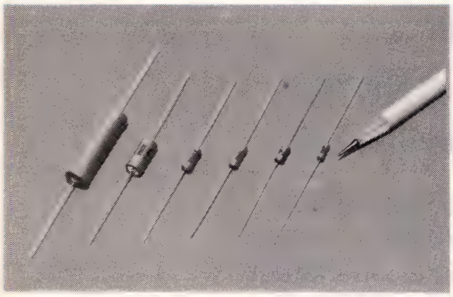

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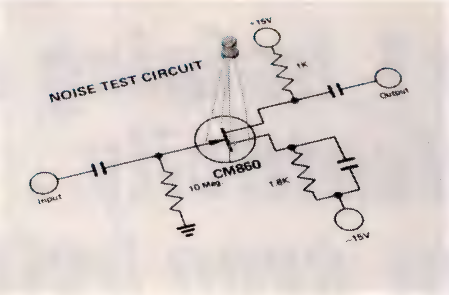

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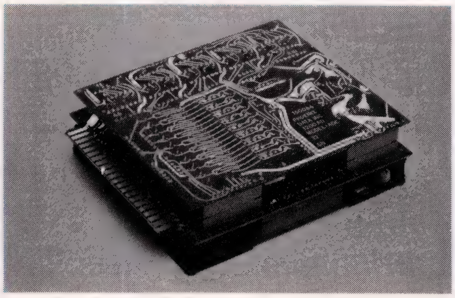

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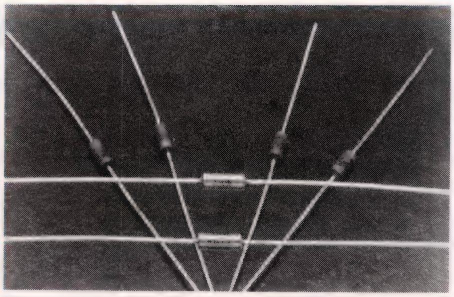

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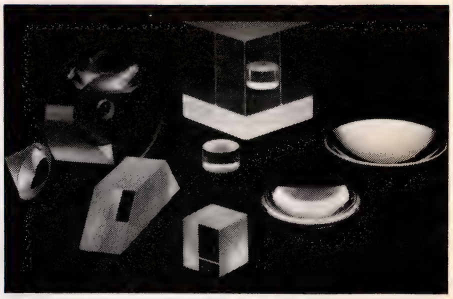

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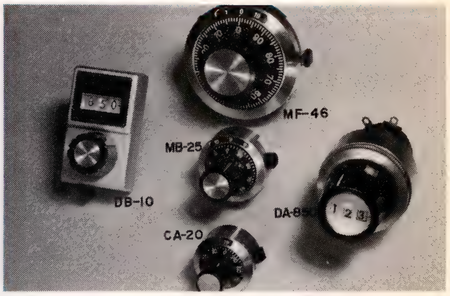

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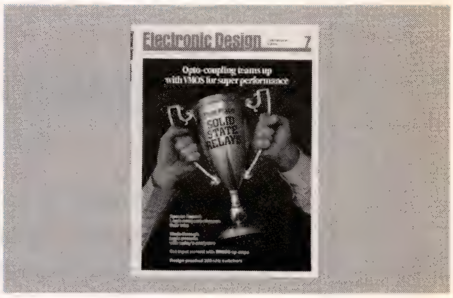

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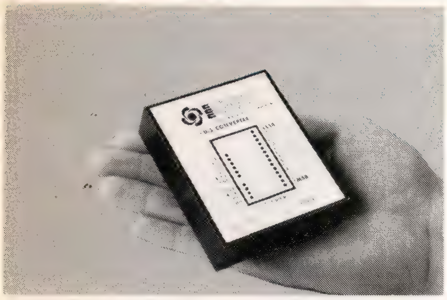

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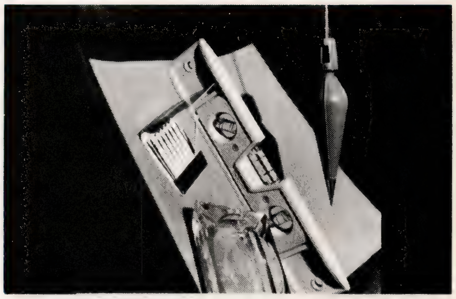

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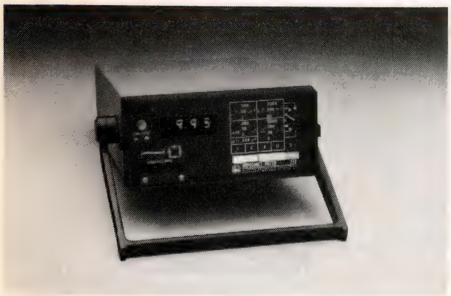

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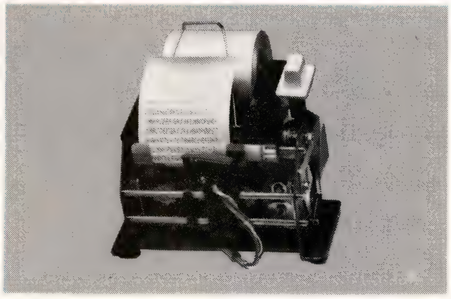

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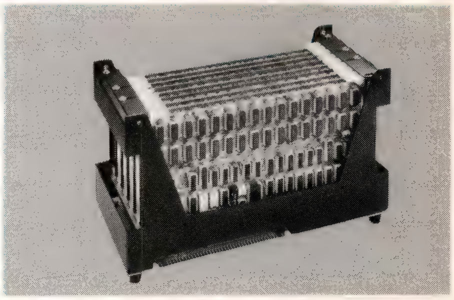

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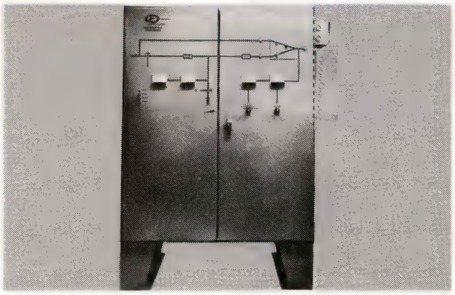

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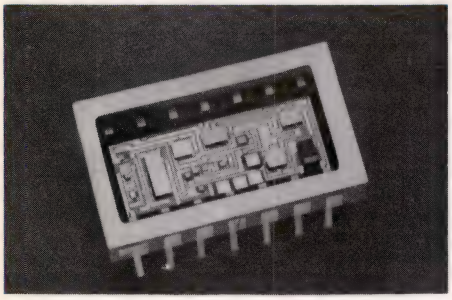

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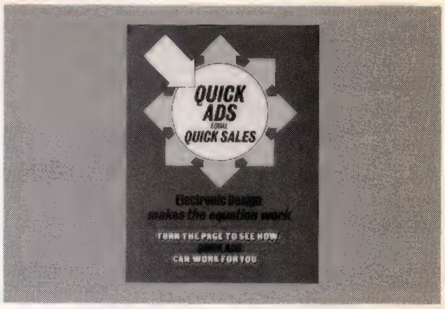

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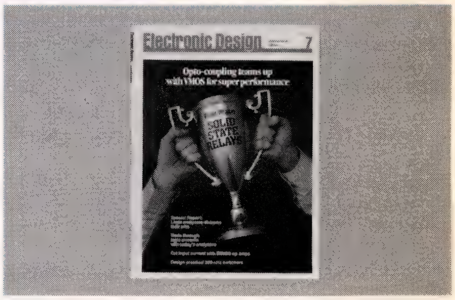

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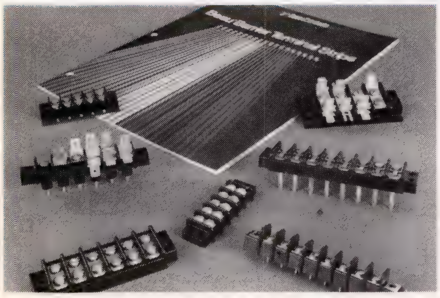

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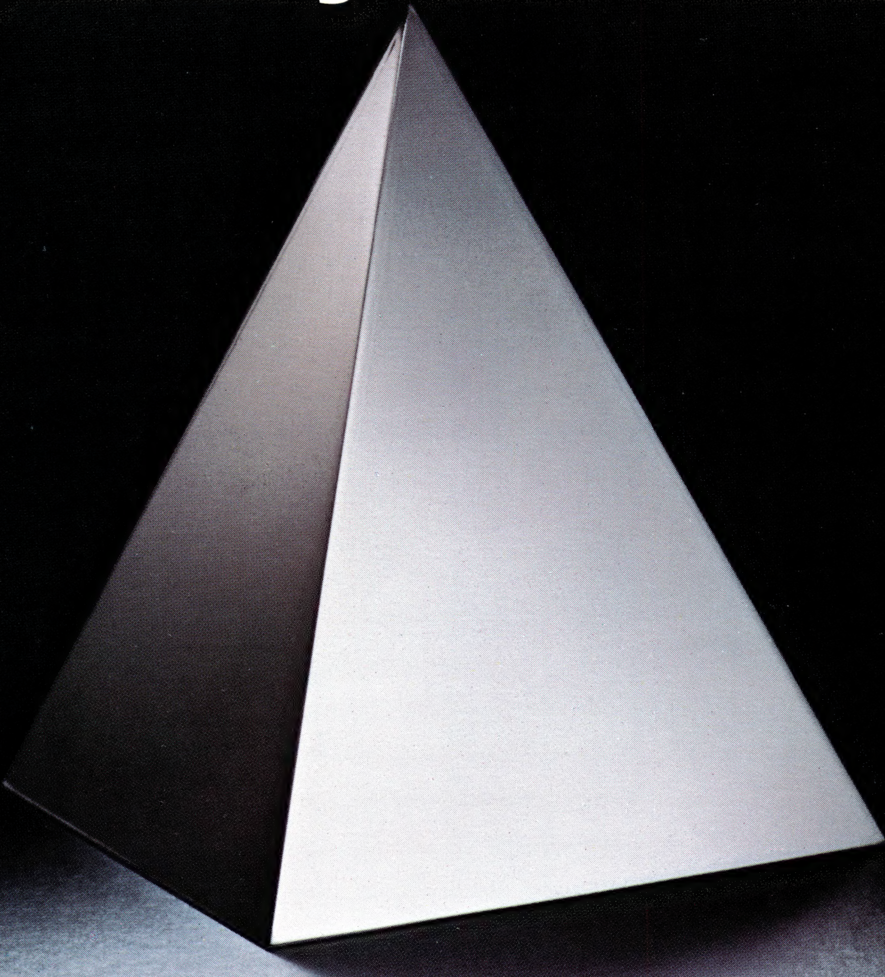

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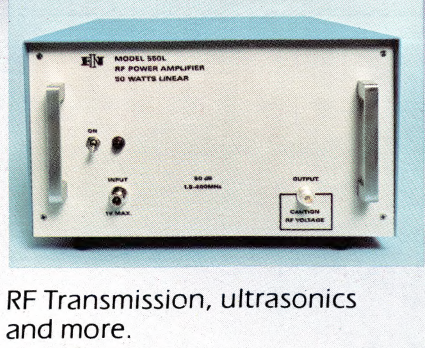

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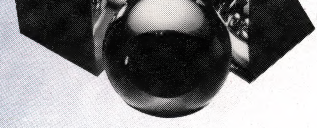

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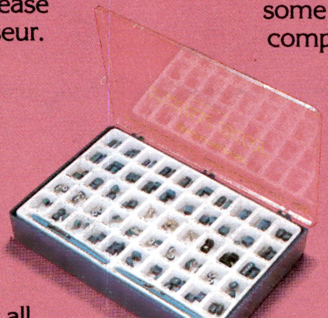

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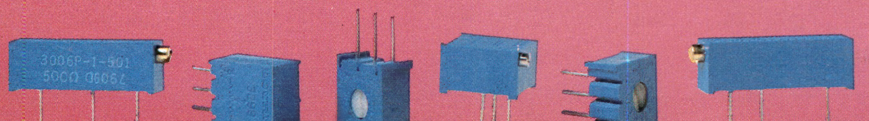

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